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(54) Method and apparatus for high rate packet data transmission

Verfahren und Anordnung zur Hochgeschwindigkeits bertragung von Datenpaketen

ProcØdØ et appareil de transmission de donnØes par paquets dØbit ØlevØ

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Description

BACKGROUND OF THE INVENTION

I. Field of the Invention

[0001] The present invention relates to data communication. More particularly, the present inventic and improved method and apparatus for high rate packet data transmission.

II. Description of the Related Art

[0002] A modern day communication system is required to support a variety of applications. One such system is a code division multiple access (CDMA) system which conforms to the "TIA/EIA/IS-95 Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System", hereinafter referred the IS-95 standard. The CDMA system allows for voice and data communications between users over a te The use of CDMA techniques in a multiple access communication system is disclosed in U.S. Patent entitled "SPREAD SPECTRUM MULTIPLE ACCESS COMMUNICATION SYSTEM USING SATELLITE OR TERRESTRIAL REPEATERS", and U.S. Patent No. 5,103,459, entitled "SYSTEM AND METHOD FOR GENERATING WAVEFORMS IN A CDMA CELLULAR TELEPHONE SYSTEM", both assigned to the assignee of the present invention

[0003] In this specification, base station refers to the hardware with which the mobile stations con to the hardware or the geographic coverage area, depending on the context in which the term is u partition of a cell. Because a sector of a CDMA system has the attributes of a cell, the teaching cells are readily extended to sectors.

[0004] In the CDMA system, communications between users are conducted through one or more base s first user on one mobile station communicates to a second user on a second mobile station by trans reverse link to a base station. The base station receives the data and can route the data to anot data is transmitted on the forward link of the same base station, or a second base station, to the The forward link refers to transmission from the base station to a mobile station and the reverse li from the mobile station to a base station. In IS-95 systems, the forward link and the reverse link are allocated frequencies.

[0005] The mobile station communicates with at least one base station during a communication. CDMA m are capable of communicating with multiple base stations simultaneously during soft handoff. Soft h of establishing a link with a new base station before breaking the link with the previous base minimizes the probability of dropped calls. The method and system for providing a communication wi through more than one base station during the soft handoff process are disclosed in U.S. Patent No "MOBILE ASSISTED SOFT HANDOFF IN A CDMA CELLULAR TELEPHONE SYSTEM," assigned to the assignee of the present invention. Softer handoff is the process whereby the communication occurs over multipl serviced by the same base station. The process of softer handoff is described in detail in copending Serial No. 08/763,498, entitled "METHOD AND APPARATUS FOR PERFORMING HANDOFF BETWEEN SECTORS OF A COMMON BASE STATION", filed December 11, 1996, assigned to the assignee of the present invent

[0006] Given the growing demand for wireless data applications, the need for very efficient wireless systems has become increasingly significant. The IS-95 standard is capable of transmitting traffic data and vo over the forward and reverse links. A method for transmitting traffic data in code channel frames of in detail in U.S. Patent No. 5/504,773, entitled "METHOD AND APPARATUS FOR THE FORMATTING OF DATA TRANSMISSION", assigned to the assignee of the present invention. In accordance with the IS-95 standard, the traffic data or voice data is partitioned into code channel frames which are 20 msec wide with data rates a

[0007] A significant difference between voice services and data services is the fact that the form and fixed delay requirements. Typically, the overall one-way delay of speech frames must be less than 100 msec. contrast, the data delay can become a variable parameter used to optimize the efficiency of the system. Specifically, more efficient error correcting coding techniques which require significantly that can be tolerated by voice services can be utilized. An exemplary efficient coding scheme fo U.S. Patent Application Serial No. 08/743,688, entitled "SOFT DECISION OUTPUT DECODER FOR DECODING VOLUTIONALLY ENCODED CODEWORDS", filed November 6, 1996, assigned to the assignee of the present inv

[0008] Another significant difference between voice services and data services is that the former r common grade of service (GOS) for all users. Typically, for digital systems providing voice servic a fixed and equal transmission rate for all users and a maximum tolerable value for the error rates In contrast, for data services, the GOS can be different from user to user and can be a parameter o the overall efficiency of the data communication system. The GOS of a data communication system is

as the total delay incurred in the transfer of a predetermined amount of data, hereinafter referre

[0009] Yet another significant difference between voice services and data services is that the forme communication link which, in the exemplary CDMA communication system, is provided by soft handof results in redundant transmissions from two or more base stations to improve reliability. However, t is not required for data transmission because the data packets received in error can be retransmitt the transmit power used to support soft handoff can be more efficiently used for transmitting addi

[0010] The parameters which measure the quality and effectiveness of a data communication system a mission delay required to transfer a data packet and the average throughput rate of the system. does not have the same impact in data communication as it does for voice communication, but it is for measuring the quality of the data communication system. The average throughput rate is a measur of the data transmission capability of the communication system.

[0011] It is well known that in cellular systems the signal-to-noise-and-interference ratio C/I of any given user i function of the location of the user within the coverage area. In order to maintain a given leve FDMA systems resort to frequency reuse techniques, i.e. not all frequency channels and/or time slo base station. In a CDMA system, the same frequency allocation is reused in every cell of the syster the overall efficiency. The C/I that any given user s mobile station achieves determines the infor supported for this particular link from the base station to the user s mobile station. Given the error correction method used for the transmission, which the present invention seek to optimize fo a given level of performance is achieved at a corresponding level of C/I. For idealized cellular cell layouts and utilizing a common frequency in every cell, the distribution of C/I achieved with be calculated.

[0012] The C/I achieved by any given user is a function of the path loss, which for terrestrial cell as $1/r^3$ to $1/r^5$, where r is the distance to the radiating source. Furthermore, the path loss is subject to to man-made or natural obstructions within the path of the radio wave. These random variations are as a lognormal shadowing random process with a standard deviation of 8 dB. The resulting C/I distr an ideal hexagonal cellular layout with omni-directional base station antennas, r^4 propagation law, and shadowing process with 8 dB standard deviation is shown in Fig. 10.

[0013] The obtained C/I distribution can only be achieved if, at any instant in time and at any station is served by the best base station which is defined as that achieving the largest C/I v physical distance to each base station. Because of the random nature of the path loss as describe with the largest C/I value can be one which is other than the minimum physical distance from th contrast, if a mobile station was to communicate only via the base station of minimum distance, the C degraded. It is therefore beneficial for mobile stations to communicate to and from the best serv times, thereby achieving the optimum C/I value. It can also be observed that the range of values o the above idealized model and as shown in FIG. 10, is such that the difference between the highes can be as large as 10,000. In practical implementation the range is typically limited to approxima 100 or 20 dB. It is therefore possible for a CDMA base station to serve mobile stations with information bit rate much as a factor of 100, since the following relationship holds:

$$R_b = W \frac{(C/I)}{(E_b/I_o)}, \qquad (1)$$

where R_b represents the information rate to a particular mobile station, W is the total bandwidth o spectrum signal, and E_b/I_o is the energy per bit over interference density required to achieve a given leve For instance, if the spread spectrum signal occupies a bandwidth W of 1.2288 MHz and reliable commu an average E_b/I_o equal to 3 dB, then a mobile station which achieves a C/I value of 3 dB to the best communicate at a data rate as high as 1.2288 Mbps. On the other hand, if a mobile station is su interference from adjacent base stations and can only achieve a C/I of -7 dB, reliable communication at a rate greater than 122.88 Kbps. A communication system designed to optimize the average through attempts to serve each remote user from the best serving base station and at the highest data rate R_b which the remote user can reliably support. The data communication system of the present invention exploits the chara and optimizes the data throughput from the CDMA base stations to the mobile stations.

[0014] From the US patent 6,134,220, a method of adapting the air interface in a mobile radio system base transceiver station, mobile station and transmission mode are known. For adaptation of the system, two separate analyses of transmission quality are carried out for each transmission dire transmission direction, one of the coding modes is selected in accordance with the corresponding t

analysis.

[0015] From the US patent 5,638,412, a method and apparatus for negotiating service configuration munication system is known. The service configuration comprises data rates, frame formats and type

[0016] WO 97/09810 relates to a method and apparatus for multirate data communication. In one e system is provided for multirate communications allowing for different data rates for each data unit both data units from different mobile units and from the same mobile unit. A sending unit preferably the rate at which to start communications, and monitors, for example by use of an RSSI detector, the rate should be changed. A rate adjustor implements the change, and can make changes as frequent unit.

SUMMARY OF THE INVENTION

[0017] The invention is defined in the independent claims 1, 7, 19, 31.

[0018] The present invention is a novel and improved method and apparatus for high rate packet da in a CDMA system. The present invention improves the efficiency of a CDMA system by providing for mitting data on the forward and reverse links. Each mobile station communicates with one or more monitors the control channels for the duration of the communication with the base stations. The be used by the base stations to transmit small amounts of data, paging messages addressed to a speci and broadcast messages to all mobile stations. The paging message informs the mobile station tha has a large amount of data to transmit to the mobile station.

[0019] It is an object of the present invention to improve utilization of the forward and reverse communication system. Upon receipt of the paging messages from one or more base stations, the mobi ures the signal-to-noise-and-interference ratio (C/I) of the forward link signals (e.g. the forward link p time slots and selects the best base station using a set of parameters which can comprise the pres measurements. In an exemplary embodiment which is not part of the invention, at every time slot, transmits to the selected base station on a dedicated data request (DRC) channel a request for highest data rate which the measured C/I can reliably support. The selected base station transmits at a data rate not exceeding the data rate received from the mobile station on the DRC channel. the best base station at every time slot, improved throughput and transmission delay are achieved

[0020] It is another exemplary embodiment which is not part of the present invention to improve transmitting from the selected base station at the peak transmit power for the duration of one o mobile station at the data rate requested by the mobile station. In the exemplary CDMA communica base stations operate at a predetermined back-off (e.g. 3 dB) from the available transmit power to account for in usage. Thus, the average transmit power is half of the peak power. However, in the present in speed data transmissions are scheduled and power is typically not shared (e.g., among transmissions) to back-off from the available peak transmit power.

[0021] It is yet another exemplary embodiment which is not part of the present invention to enha allowing the base stations to transmit data packets to each mobile station for a variable number o to transmit from different base stations from time slot to time slot allows the data communicatio invention to quickly adopt to changes in the operating environment. In addition, the ability to tr non-contiguous time slots is possible in the present invention because of the use of sequence num data units within a data packet.

[0022] It is yet another exemplary embodiment which is not part of the present invention to inc forwarding the data packets addressed to a specific mobile station from a central controller to a are members of the active set of the mobile station. In the present invention, data transmission ca station in the active set of the mobile station at each time slot. Since each base station comprise the data to be transmitted to the mobile station, efficient forward link transmission can occur with

[0023] It is yet another exemplary embodiment which is not part of the present invention to provi mechanism for data units received in error. In the exemplary embodiment, each data packet comprise number of data units, with each data unit identified by a sequence number. Upon incorrect recept data units, the mobile station sends a negative acknowledgment (NACK) on the reverse link data cha sequence numbers of the missing data units for retransmission from the base station. The base st NACK message and can retransmit the data units received in error.

[0024] It is yet another exemplary embodiment which is not part of the present invention for the mo the best base station candidates for communication based on the procedure described in U.S. Patent No. 08/790,497, entitled "METHOD AND APPARATUS FOR PERFORMING SOFT HANDOFF IN A WIRELESS COMMUNICATION SYSTEM", filed January 29, 1997, assigned to the assignee of the present invention. In embodiment, the base station can be added to the active set of the mobile station if the received

predetermined add threshold and dropped from the active set if the pilot signal is below a predeter In the alternative embodiment, the base station can be added to the active set if the additional en (e.g. as measured by the pilot signal) and the energy of the base stations already in the active set threshold. Using this alternative embodiment, a base station which transmitted energy comprises an i of the total received energy at the mobile station is not added to the active set.

[0025] It is yet another exemplary embodiment which is not part of the present invention for the transmit the data rate requests on the DRC channel in a manner such that only the selected base base stations in communication with the mobile station is able to distinguish the DRC messages, the the forward link transmission at any given time slot is from the selected base station. In the e each base station in communication with the mobile station is assigned a unique Walsh code. The mob the DRC message with the Walsh code corresponding to the selected base station. Other codes can be the DRC messages, although orthogonal codes are typically utilized and Walsh codes are preferred.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The features, objects, and advantages of the present invention will become more apparent f description set forth below when taken in conjunction with the drawings in which like reference correspondingly throughout and wherein:

FIG. 1 is a diagram of a data communication system of the present invention comprising a pluralit of base stations and a plurality of mobile stations.
FIG. 2 is an exemplary block diagram of the subsystems of the data communication system of the p
FIGS. 3A-3B are block diagrams of the exemplary forward link architecture of the present inventi
FIG. 4A is a diagram of the exemplary forward link frame structure of the present invention;
FIGS. 4B-4C are diagrams of the exemplary forward traffic channel and power control channel, res
FIG. 4D is a diagram of the punctured packet of the present invention;
FIGS. 4E-4G are diagrams of the two exemplary data packet formats and the control channel capsule
FIG. 5 is an exemplary timing diagram showing the high rate packet transmission on the forward
FIG. 6 is a block diagram of the exemplary reverse link architecture of the present invention;
FIG. 7A is a diagram of the exemplary reverse link frame structure of the present invention;
FIGS. 7B is a diagram of the exemplary reverse link access channel;
FIG. 8 is an exemplary timing diagram showing the high rate data transmission on the reverse l
FIG. 9 is an exemplary state diagram showing the transitions between the various operating st station; and
FIG. 10 is a diagram of the cumulative distribution function (CDF) of the C/I distribution in an layout.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] In accordance with the exemplary embodiment of the data communication system of the prese forward link data transmission occurs from one base station to one mobile station (see FIG. 1) at data rate which can be supported by the forward link and the system. Reverse link data communicati one mobile station to one or more base stations. The calculation of the maximum data rate for forw is described in detail below. Data is partitioned into data packets, with each data packet being more time slots (or slots). At each time slot, the base station can direct data transmission to an in communication with the base station..

[0028] Initially, the mobile station establishes communication with a base station using a predete cedure. In this connected state, the mobile station can receive data and control messages from the able to transmit data and control messages to the base station. The mobile station then monitors transmissions from the base stations in the active set of the mobile station. The active set contai in communication with the mobile station. Specifically, the mobile station measures the carrier-to-interference signal-ratio (C/I) of the forward link pilot from the base stations in the active set, as received at the m pilot signal is above a predetermined add threshold or below a predetermined drop threshold, the mo this to the base station. Subsequent messages from the base station direct the mobile station to a station(s) to or from its active set, respectively. The various operating states of the mobile stati

[0029] If there is no data to send, the mobile station returns to an idle state and discontinues tr information to the base station(s). While the mobile station is in the idle state, the mobile station mon channel from one or more base stations in the active set for paging messages.

[0030] If there is data to be transmitted to the mobile station, the data is sent by a central cont in the active set and stored in a queue at each base station. A paging message is then sent by one c to the mobile station on the respective control channels. The base station may transmit all such the same time across several base stations in order to ensure reception even when the mobile st between base stations. The mobile station demodulates and decodes the signals on one or more cont receive the paging messages.

[0031] Upon decoding the paging messages, and for each time slot until the data transmission is comp station measures the C/I of the forward link signals from the base stations in the active set, as station. The C/I of the forward link signals can be obtained by measuring the respective pilot sign then selects the best base station based on a set of parameters. The set of parameters can compris previous C/I measurements and the rate or packet error rate. For example, the best base station can be sele based on the largest C/I measurement. The mobile station then identifies the best base station a selected base station a data request message (hereinafter referred to as the DRC message) on the dat (hereinafter referred to as the DRC channel). In an embodiment which is not part of the invention can contain the requested data rate. Alternatively, in an embodiment which is part of the inventi contains an indication of the quality of the forward link channel (e.g., the C/I measurement itse the packet error rate). In the exemplary embodiment, the mobile station can direct the transmission of t to a specific base station by the use of a Walsh code which uniquely identifies the base station symbols are exclusively OR ed (XOR) with the unique Walsh code. Since each base station in the activ station is identified by a unique Walsh code, only the selected base station which performs the id as that performed by the mobile station, with the correct Walsh code, can correctly decode the DRC station uses the rate control information from each mobile station to efficiently transmit forwar possible rate.

[0032] At each time slot, the base station can select any of the paged mobile stations for data tra station then determines the data rate at which to transmit the data to the selected mobile stati recent value of the DRC message received from the mobile station. Additionally, the base station transmission to a particular mobile station by using a spreading code which is unique to that m exemplary embodiment, this spreading code is the long pseudo noise (PN) code which is defined by I 95 standard.

[0033] The mobile station, for which the data packet is intended, receives the data transmission an packet. Each data packet comprises a plurality of data units. In the exemplary embodiment, a data information bits, although different data unit sizes can be defined and are within the scope of t the exemplary embodiment, each data unit is associated with a sequence number and the mobile stat identify either missed or duplicative transmissions. In such events, the mobile stations communica data channel the sequence numbers of the missing data units. The base station controllers, which messages from the mobile stations, then indicate to all base stations communicating with this part which data units were not received by the mobile station. The base stations then schedule a retrans units.

[0034] Each mobile station in the data communication system can communicate with multiple base st reverse link. In the exemplary embodiment, the data communication system of the present invention su and softer handoff on the reverse link for several reasons. First, soft handoff does not consume the reverse link but rather allows the mobile stations to transmit data at the minimum power level of the base stations can reliably decode the data. Second, reception of the reverse link signals increases the reliability of the transmission and only requires additional hardware at the base st

[0035] In exemplary embodiment which is not part of the invention, the forward link capacity of th system of the present invention is determined by the rate requests of the mobile stations. Addition link capacity can be achieved by using directional antennas and/or adaptive spatial filters. An e apparatus for providing directional transmissions are disclosed in copending U.S. Patent Applicat entitled "METHOD AND APPARATUS FOR DETERMINING THE TRANSMISSION DATA RATE IN A MULTI-USER COMMUNICATION SYSTEM", filed December 20, 1995, and U.S. Patent Application Serial No. 08/925,521 "METHOD AND APPARATUS FOR PROVIDING ORTHOGONAL SPOT BEAMS, SECTORS, AND PICOCELLS", filed September 8, 1997, both assigned to the assignee of the present invention..

I. System Description

[0036] Referring to the figures, FIG. 1 represents the exemplary data communication system of the p which comprises multiple cells 2a – 2g. Each cell 2 is serviced by a corresponding base station 4. Various mobile stations 6 are dispersed throughout the data communication system. In the exemplary embodiment, each of mobile stations 6 communicates with at most one base station 4 on the forward link at each time slot but can be in communicat

one or more base stations 4 on the reverse link, depending on whether the mobile station 6 is in soft handoff. For example, base station 4a transmits data exclusively to mobile station 6a, base station 4b transmits data exclusively to mobile station 6b, and base station 4c transmits data exclusively to mobile station 6c on the forward link at time slot n. In F 1, the solid line with the arrow indicates a data transmission from base station 4 to mobile station 6. A broken line wit the arrow indicates that mobile station 6 is receiving the pilot signal, but no data transmission, from base s 4. The reverse link communication is not shown in FIG. 1 for simplicity.

[0037] As shown by FIG. 1, each base station 4 preferably transmits data to one mobile station 6 at any given moment. Mobile stations 6, especially those located near a cell boundary, can receive the pilot signals from mul 4. If the pilot signal is above a predetermined threshold, mobile station 6 can request that base station 4 be added to the active set of mobile station 6. In the exemplary embodiment, mobile station 6 can receive data transmission from zero or one member of the active set.

[0038] A block diagram illustrating the basic subsystems of the data communication system of the p is shown in FIG. 2. Base station controller 10 interfaces with packet network interface 24, PSTN 30, and all base stations 4 in the data communication system (only one base station 4 is shown in FIG. 2 for simplicity). Base station co 10 coordinates the communication between mobile stations 6 in the data communication system and other users co nected to packet network interface 24 and PSTN 30. PSTN 30 interfaces with users through the standard teleph network (not shown in FIG. 2).

[0039] Base station controller 10 contains many selector elements 14, although only one is shown in FIG. 2 fo simplicity. One selector element 14 is assigned to control the communication between one or more base statio 4 and one mobile station 6. If selector element 14 has not been assigned to mobile station 6, call control processor 16 is informed of the need to page mobile station 6. Call control processor 16 then directs base station 4 to page mobile station 6.

[0040] Data source 20 contains the data which is to be transmitted to mobile station 6. Data source 20 provides the data to packet network interface 24. Packet network interface 24 receives the data and routes the data to selec element 14. Selector element 14 sends the data to each base station 4 in communication with mobile station 6. Each base station 4 maintains data queue 40 which contains the data to be transmitted to mobile station 6.

[0041] In the exemplary embodiment, on the forward link, a data packet refers to a predetermined which is independent of the data rate. The data packet is formatted with other control and coding data transmission occurs over multiple Walsh channels, the encoded packet is demultiplexed into par each stream transmitted over one Walsh channel.

[0042] The data is sent, in data packets, from data queue 40 to channel element 42. For each data packet, channel element 42 inserts the necessary control fields. The data packet, control fields, frame check seque tail bits comprise a formatted packet. Channel element 42 then encodes one or more formatted packets and interlea (or reorders) the symbols within the encoded packets. Next, the interleaved packet is scrambled sequence, covered with Walsh covers, and spread with the long PN code and the short PN_I and PN_Q codes. The spread data is quadrature modulated, filtered, and amplified by a transmitter within RF unit 44. The forward link signal is transmitted over the air through antenna 46 on forward link 50.

[0043] At mobile station 6, the forward link signal is received by antenna 60 and routed to a receiver within front en 62. The receiver filters, amplifies, quadrature demodulates, and quantizes the signal. The digitiz demodulator (DEMOD) 64 where it is despread with the long PN code and the short PN_I and PN_Q codes, decovered with the Walsh covers, and descrambled with the identical scrambling sequence. The demodulated dat decoder 66 which performs the inverse of the signal processing functions done at base station 4, specifically the deinterleaving, decoding, and frame check functions. The decoded data is provided to data sink 68. The hardware, as described above, supports transmissions of data, messaging, voice, video, and other communications link.

[0044] The system control and scheduling functions can be accomplished by many implementations. Th channel scheduler 48 is dependent on whether a centralized or distributed control/scheduling processing is desired. For example, for distributed processing, channel scheduler 48 can be located within each base station 4. Conversely, for centralized processing, channel scheduler 48 can be located within base station controller 10 and can be designed to coordinate the data transmissions of multiple base stations 4. Other implementations of the above described functi can be contemplated and are within the scope of the present invention.

[0045] As shown in FIG. 1, mobile stations 6 are dispersed throughout the data communication system and can in communication with zero or one base station 4 on the forward link. In the exemplary embodiment, channel sch 48 coordinates the forward link data transmissions of one base station 4. In the exemplary embodiment, channel scheduler 48 connects to data queue 40 and channel element 42 within base station 4 and receives the queue size, which is indicative of the amount of data to transmit to mobile station 6, and the DRC messages from mobile stations 6. Channel scheduler 48 schedules high rate data transmission such that the system goals of maximum data throughpu transmission delay are optimized.

[0046] In the exemplary embodiment, the data transmission is scheduled based in part on the qualit

nication link. An exemplary communication system which selects the transmission rate based on t disclosed in U.S. Patent Application Serial No. 08/741,320, entitled "METHOD AND APPARATUS FOR PR HIGH SPEED DATA COMMUNICATIONS IN A CELLULAR ENVIRONMENT", filed September 11, 1996, assigned to the assignee of the present invention. In the present invention, the scheduling of the data commun on additional considerations such as the GOS of the user, the queue size, the type of data, the amo experienced, and the error rate of the data transmission. These considerations are described in Application No. 08/798,951, entitled "METHOD AND APPARATUS FOR FORWARD LINK RATE SCHEDULING", file February 11, 1997, and U.S. Patent Application Serial No. ___, entitled "METHOD AND APPARATUS FOR REVERSE LINK RATE SCHEDULING", filed August 20, 1997, both are assigned to the assignee of th invention. Other factors can be considered in scheduling data transmissions and are within the s invention.

[0047] The data communication system of the present invention supports data and message transmis reverse link. Within mobile station 6, controller 76 processes the data or message transmission by routing the da message to encoder 72. Controller 76 can be implemented in a microcontroller, a microprocessor, a digi processing (DSP) chip, or an ASIC programmed to perform the function as described herein.

[0048] In the exemplary embodiment, encoder 72 encodes the message consistent with the Blank and Burst sign data format described in the aforementioned U.S. Patent No. 5,504,773. Encoder 72 then generates and appends a set of CRC bits, appends a set of code tail bits, encodes the data and appended bits, and reorders the encoded data. The interleaved data is provided to modulator (MOD) 74.

[0049] Modulator 74 can be implemented in many embodiments. In the exemplary embodiment (see FIG. interleaved data is covered with Walsh codes, spread with a long PN code, and further spread with t The spread data is provided to a transmitter within front end 62. The transmitter modulates, filters, amplifies, and tr the reverse link signal over the air, through antenna 50, on reverse link 52.

[0050] In the exemplary embodiment, mobile station 6 spreads the reverse link data in accordance with a lon code. Each reverse link channel is defined in accordance with the temporal offset of a common lon two differing offsets the resulting modulation sequences are uncorrelated. The offset of mobile station 6 is determined in accordance with a unique numerical identification of mobile station 6, which in the exemplary embodiment of the IS-95 mobile station 6 is the mobile station specific identification number. Thus, each mobile station 6 transmits on one uncorrelated reverse link channel determined in accordance with its unique electronic serial numbe

[0051] At base station 4, the reverse link signal is received by antenna 40 and provided to RF unit 44. RF unit 44 filters, amplifies, demodulates, and quantizes the signal and provides the digitized signal to chan element 42. Channel element 42 despreads the digitized signal with the short PN codes and the long PN code. Channel element 42 also performs the Walsh code decovering and pilot and DRC extraction. Channel element 42 then reorders the demodulated data, decodes the deinterleaved data, and performs the CRC check function. The decoded data, e.g. message, is provided to selector element 14. Selector element 14 routes the data and message to the appropriat destination. Channel element 42 may also forward a quality indicator to selector element 14 indicative of the condition of the received data packet.

[0052] In the exemplary embodiment, mobile station 6 can be in one of three operating states. An exemplary diagram showing the transitions between the various operating states of mobile station 6 is shown in FIG. 9. In the access state 902, mobile station 6 sends access probes and waits for channel assignment by base station 4. The channel assignment comprises allocation of resources, such as a power control channel and frequency allocat 6 can transition from the access state 902 to the connected state 904 if mobile station 6 is paged and alerted to an upcoming data transmission, or if mobile station 6 transmits data on the reverse link. In the connected state 904, mobile station 6 exchanges (e.g., transmits or receives) data and performs handoff operations. Upon complet procedure, mobile station 6 transitions from the connected state 904 to the idle state 906. Mobile station 6 can also transition from the access state 902 to the idle state 906 upon being rejected of a connection with base station 4. In the idle state 906, mobile station 6 listens to overhead and paging messages by receiving and decoding messa the forward control channel and performs idle handoff procedure. Mobile station 6 can transition to the access state 902 by initiating the procedure. The state diagram shown in FIG. 9 is only an exemplary state definit illustration. Other state diagrams can also be utilized and are within the scope of the present in

II. Forward Link Data Transmission

[0053] In the exemplary embodiment, the initiation of a communication between mobile station 6 and base station 4 occurs in a similar manner as that for the CDMA system. After completion of the call set up, mobi the control channel for paging messages. While in the connected state, mobile station 6 begins transmission of the pilot signal on the reverse link.

[0054] An exemplary flow diagram of the forward link high rate data transmission of the present in

FIG. 5. If base station 4 has data to transmit to mobile station 6, base station 4 sends a paging message addressed to mobile station 6 on the control channel at block 502. The paging message can be sent from one or multiple base sta 4, depending on the handoff state of mobile station 6. Upon reception of the paging message, mobile station 6 begins the C/I measurement process at block 504. The C/I of the forward link signal is calculated from one or a co methods described below. Mobile station 6 then selects a requested data rate based on the best C/I measureme transmits a DRC message on the DRC channel at block 506.

[0055] Within the same time slot, base station 4 receives the DRC message at block 508. If the next time slot is available for data transmission, base station 4 transmits data to mobile station 6 at the requested data rate at block 510. Mobile station 6 receives the data transmission at block 512. If the next time slot is available, base station 4 transmits the remainder of the packet at block 514 and mobile station 6 receives the data transmission at block 516.

[0056] In the present invention, mobile station 6 can be in communication with one or more base stations 4 simultaneously. The actions taken by mobile station 6 depend on whether mobile station 6 is or is not in soft handoff. Thes two cases are discussed separately below.

III. No Handoff Case

[0057] In the no handoff case, mobile station 6 communicates with one base station 4. Referring to FIG. 2, the data destined for a particular mobile station 6 is provided to selector element 14 which has been assigned to control the communication with that mobile station 6. Selector element 14 forwards the data to data queue 40 within base station 4. Base station 4 queues the data and transmits a paging message on the control channel. Base station 4 then monitors the reverse link DRC channel for DRC messages from mobile station 6. If no signal is detected on the DRC channe base station 4 can retransmit the paging message until the DRC message is detected. After a predeterm of retransmission attempts, base station 4 can terminate the process or re-initiate a call with mobile station 6.

[0058] In the exemplary embodiment which is not part of the invention, mobile station 6 transmits the requested data rate, in the form of a DRC message, to base station 4 on the DRC channel. In the alternative embodiment, mobile st 6 transmits an indication of the quality of the forward link channel (e.g., the C/I measurement) t 4. In the exemplary embodiment, the 3-bit DRC message is decoded with soft decisions by base station 4. In the exemplary embodiment, the DRC message is transmitted within the first half of each time slot. Base station 4 then has the remaining half of the time slot to decode the DRC message and configure the hardware for data transmission at time slot, if that time slot is available for data transmission to this mobile station 6. If the next successive time slot is n available, base station 4 waits for the next available time slot and continues to monitor the DRC channe DRC messages.

[0059] In the first embodiment which is not part of the invention, base station 4 transmits at the requested data rate. This embodiment confers to mobile station 6 the important decision of selecting the data rate. Always transmi requested data rate has the advantage that mobile station 6 knows which data rate to expect. Thus, mobile stati 6 only demodulates and decodes the traffic channel in accordance with the requested data rate. Base 4 does not have to transmit a message to mobile station 6 indicating which data rate is being used by base station 4.

[0060] In the first embodiment which is not part of the invention, after reception of the paging me 6 continuously attempts to demodulate the data at the requested data rate. Mobile station 6 demodulates the forward traffic channel and provides the soft decision symbols to the decoder. The decoder decodes the sym the frame check on the decoded packet to determine whether the packet was received correctly. I received in error or if the packet was directed for another mobile station 6, the frame check would indicate a packet erro Alternatively in the first embodiment, mobile station 6 demodulates the data on a slot by slot basis. In the exe embodiment, mobile station 6 is able to determine whether a data transmission is directed for it based which is incorporated within each transmitted data packet, as described below. Thus, mobile station 6 can terminate the decoding process if it is determined that the transmission is directed for another mobile station 6. In either case, mobile station 6 transmits a negative acknowledgments (NACK) message to base station 4 to acknowledge the incorrect reception of the data units. Upon receipt of the NACK message, the data units received in error is

[0061] The transmission of the NACK messages can be implemented in a manner similar to the transm error indicator bit (EIB) in the CDMA system. The implementation and use of EIB transmission are Patent No. 5,568,483, entitled "METHOD AND APPARATUS FOR THE FORMATTING OF DATA FOR TRANSMIS-SION", assigned to the assignee of the present invention. Alternatively, NACK can be transmitted w

[0062] In the second embodiment, the data rate is determined by base station 4 with input from mobile station 6. Mobile station 6 performs the C/I measurement and transmits an indication of the link quality (e.g., the to base station 4. Base station 4 can adjust the requested data rate based on the resources available to bas 4, such as the queue size and the available transmit power. The adjusted data rate can be transmitted 6 prior to or concurrent with data transmission at the adjusted data rate, or can be implied in th packets. In the first case, wherein mobile station 6 receives the adjusted data rate before the data transmission

station 6 demodulates and decodes the received packet in the manner described in the first embodiment case, wherein the adjusted data rate is transmitted to mobile station 6 concurrent with the data transmission, mobil station 6 can demodulate the forward traffic channel and store the demodulated data. Upon receipt of rate, mobile station 6 decodes the data in accordance with the adjusted data rate. And in the third cas adjusted data rate is implied in the encoded data packets, mobile station 6 demodulates and decodes all candidate rates and determine aposteriori the transmit rate for selection of the decoded data. The method and appar rate determination are described in detail in U.S. Patent Application Serial No. 08/730,863, ent APPARATUS FOR DETERMINING THE RATE OF RECEIVED DATA IN A VARIABLE RATE COMMUNICATION SYS-TEM", filed October 18, 1996, and Patent Application Serial No. PA436, also entitled "METHOD AND FOR DETERMINING THE RATE OF RECEIVED DATA IN A VARIABLE RATE COMMUNICATION SYSTEM", filed ____________, both assigned to the assignee of the present invention. For all cases describe station 6 transmits a NACK message as described above if the outcome of the frame check is negative.

[0063] The discussion hereinafter is based on the first embodiment which is not part of the invent station 6 transmits to base station 4 the DRC message indicative of the requested data rate, except as otherwise However, the inventive concept described herein is equally applicable to the second embodiment wher 6 transmits an indication of the link quality to base station 4.

IV. Handoff Case

[0064] In the handoff case, mobile station 6 communicates with multiple base stations 4 on the reverse link. In the exemplary embodiment, data transmission on the forward link to a particular mobile station 6 occurs from one base station 4. However, mobile station 6 can simultaneously receive the pilot signals from multiple base stations 4. If the C/I measurement of a base station 4 is above a predetermined threshold, the base station 4 is added to the active set of mobile station 6. During the soft handoff direction message, the new base station 4 assigns mobile station 6 to a reverse power control (RPC) Walsh channel which is described below. Each base station 4 in soft handoff with mobile station 6 monitors the reverse link transmission and sends an RPC bit on their respective RPC Walsh channe

[0065] Referring to FIG. 2, selector element 14 assigned to control the communication with mobile station 6 forwards the data to all base stations 4 in the active set of mobile station 6. All base stations 4 which receive data from selector element 14 transmit a paging message to mobile station 6 on their respective control channels. When 6 is in the connected state, mobile station 6 performs two functions. First, mobile station 6 selects the best base station 4 based on a set of parameter which can be the best C/I measurement. Mobile station 6 then selects a data rate corresponding to the C/I measurement and transmits a DRC message to the selected base station 4. Mobile station 6 can direct transmission of the DRC message to a particular base station 4 by covering the DRC message with the Walsh cover assigned to that particular base station 4. Second, mobile station 6 attempts to demodulate the forward link sign in accordance with the requested data rate at each subsequent time slot.

[0066] After transmitting the paging messages, all base stations 4 in the active set monitor the DRC channel for DRC message from mobile station 6. Again, because the DRC message is covered with a Walsh code, the se base station 4 assigned with the identical Walsh cover is able to decover the DRC message. Upon recei message, the selected base station 4 transmits data to mobile station 6 at the next available time slots.

[0067] In the exemplary embodiment, base station 4 transmits data in packets comprising a plurality of data the requested data rate to mobile station 6. If the data units are incorrectly received by mobile station 6, a NACK message is transmitted on the reverse links to all base stations 4 in the active set. In the exemplary embodiment, the N message is demodulated and decoded by base stations 4 and forwarded to selector element 14 for processing. Upon processing of the NACK message, the data units are retransmitted using the procedure as describ exemplary embodiment, selector element 14 combines the NACK signals received from all base stations 4 into one NACK message and sends the NACK message to all base stations 4 in the active set.

[0068] In the exemplary embodiment, mobile station 6 can detect changes in the best C/I measurement and dynamica request data transmissions from different base stations 4 at each time slot to improve efficiency. In the exem embodiment, since data transmission occurs from only one base station 4 at any given time slot, other base stations 4 in the active set may not be aware which data units, if any, has been transmitted to mobile station 6. In the exemplary embodiment, the transmitting base station 4 informs selector element 14 of the data transmission. Selector element 14 then sends a message to all base stations 4 in the active set. In the exemplary embodiment, the transmitte presumed to have been correctly received by mobile station 6. Therefore, if mobile station 6 requests data transmission from a different base station 4 in the active set, the new base station 4 transmits the remaining data units. In the exempl embodiment, the new base station 4 transmits in accordance with the last transmission update from select 14. Alternatively, the new base station 4 selects the next data units to transmit using predictive schemes metrics such as the average transmission rate and prior updates from selector element 14. These mechanisms minimize duplicative retransmissions of the same data units by multiple base stations 4 at different time slots which results i

loss in efficiency. If a prior transmission was received in error, base station 4 can retransmit those data units out of sequence since each data unit is identified by a unique sequence number as described below. In th bodiment, if a hole (or non-transmitted data units) is created (e.g., as the result of handoff between one base station 4 to another base station 4), the missing data units are considered as though received in error. Mobile station 6 transmits NACK messages corresponding to the missing data units and these data units are retransmitted.

[0069] In the exemplary embodiment, each base station 4 in the active set maintains an independent data queue 40 which contains the data to be transmitted to mobile station 6. The selected base station 4 transmits data existing in its data queue 40 in a sequential order, except for retransmissions of data units received in error and s In the exemplary embodiment, the transmitted data units are deleted from queue 40 after transmission.

V. Other Considerations for Forward Link Data Transmissions

[0070] An important consideration in the data communication system of the present invention is th C/I estimates for the purpose of selecting the data rate for future transmissions. In the exemplar measurements are performed on the pilot signals during the time interval when base stations 4 transmit pilot signals. In the exemplary embodiment, since only the pilot signals are transmitted during this pilot time i multipath and interference are minimal.

[0071] In other implementations of the present invention wherein the pilot signals are transmitte an orthogonal code channel, similar to that for the IS-95 system, the effect of multipath and interference can dis C/I measurements. Similarly, when performing the C/I measurement on the data transmissions instead o multipath and interference can also degrade the C/I measurements. In both of these cases, when one base station 4 is transmitting to one mobile station 6, the mobile station 6 is able to accurately measure the C/I of the forward lin because no other interfering signals are present. However, when mobile station 6 is in soft handoff and receives the pilot signals from multiple base stations 4, mobile station 6 is not able to discern whether or not base stations 4 were transmitting data. In the worst case scenario, mobile station 6 can measure a high C/I at a first time slot, when no base stations 4 were transmitting data to any mobile station 6, and receive data transmission at a second time slot, wh base stations 4 are transmitting data at the same time slot. The C/I measurement at the first ti stations 4 are idle, gives a false indication of the forward link signal quality at the second time the data communication system has changed. In fact, the actual C/I at the second time slot can be d that reliable decoding at the requested data rate is not possible.

[0072] The converse extreme scenario exists when a C/I estimate by mobile station 6 is based on maximal interference. However, the actual transmission occurs when only the selected base station is transmitting, In this and selected data rate are conservative and the transmission occurs at a rate lower than that whi decoded, thus reducing the transmission efficiency.

[0073] In the implementation wherein the C/I measurement is performed on a continuous pilot sign signal, the prediction of the C/I at the second time slot based on the measurement of the C/I at t made more accurate by three embodiments. In the first embodiment, data transmissions from base stations 4 are controlled so that base stations 4 do not constantly toggle between the transmit and idle states at successi This can be achieved by queuing enough data (e.g. a predetermined number of information bits) be transmission to mobile stations 6.

[0074] In the second embodiment, each base station 4 transmits a forward activity bit (hereinafter referred FAC bit) which indicates whether a transmission will occur at the next half frame. The use of the in detail below. Mobile station 6 performs the C/I measurement taking into account the received FAC bit from station 4.

[0075] In the third embodiment, which corresponds to the scheme wherein an indication of the link qu to base station 4 and which uses a centralized scheduling scheme, the scheduling information indicating base stations 4 transmitted data at each time slot is made available to channel scheduler 48. Channel scheduler 48 receives the C/I measurements from mobile stations 6 and can adjust the C/I measurements based on its knowled of the presence or absence of data transmission from each base station 4 in the data communication system. For example, mobile station 6 can measure the C/I at the first time slot when no adjacent base stations 4 are transmitting. The measured C/I is provided to channel scheduler 48. Channel scheduler 48 knows that no adjacent base stations 4 transmitted data in the first time slot since none was scheduled by channel scheduler 48. In scheduling data transmission at the second time slot, channel scheduler 48 knows whether one or more adjacent base stations 4 will transmit data. Channel scheduler 48 can adjust the C/I measured at the first time slot to take into account the a mobile station 6 will receive in the second time slot due to data transmissions by adjacent base stations 4. Alternately, if the C/I is measured at the first time slot when adjacent base stations 4 are transmitting and these adjacent base stations 4 are not transmitting at the second time slot, channel scheduler 48 can adjust the C/I measurement to take into account the additional information.

[0076] Another important consideration is to minimize redundant retransmissions. Redundant retran result from allowing mobile station 6 to select data transmission from different base stations 4 at successive time slots. The best C/I measurement can toggle between two or more base stations 4 over successive time slots if mobile stati 6 measures approximately equal C/I for these base stations 4. The toggling can be due to deviations in the C/I m urements and/or changes in the channel condition. Data transmission by different base stations 4 at successive time slots can result in a loss in efficiency.

[0077] The toggling problem can be addressed by the use of hysterisis. The hysterisis can be imp signal level scheme, a timing scheme, or a combination of the signal level and timing schemes. In t level scheme, the better C/I measurement of a different base station 4 in the active set is not selected unless it ex the C/I measurement of the current transmitting base station 4 by at least the hysterisis quantity. As an example, a that the hysterisis is 1.0 dB and that the C/I measurement of the first base station 4 is 3.5 dB and the C/I measurement of the second base station 4 is 3.0 dB at the first time slot. At the next time slot, the second base stati 4 is not selected unless its C/I measurement is at least 1.0 dB higher than that of the first base station 4. Thus, if the C/I measurement of the first base station 4 is still 3.5 dB at the next time slot, the second base station 4 is not selected unless its C/I measurement is at least 4.5 dB.

[0078] In the exemplary timing scheme, base station 4 transmits data packets to mobile station 6 for a predetermined number of time slots. Mobile station 6 is not allowed to select a different transmitting base station 4 within the predetermined number of time slots. Mobile station 6 continues to measure the C/I of the current transmitting base statio 4 at each time slot and selects the data rate in response to the C/I measurement.

[0079] Yet another important consideration is the efficiency of the data transmission. Referring t each data packet format 410 and 430 contains data and overhead bits. In the exemplary embodiment, the nu overhead bits is fixed for all data rates. At the highest data rate, the percentage of overhead is s size and the efficiency is high. At the lower data rates, the overhead bits can comprise a larger p The inefficiency at the lower data rates can be improved by transmitting variable length data pac 6. The variable length data packets can be partitioned and transmitted to mobile station 6 over multiple time slots. Preferably the variable length data packets are transmitted to mobile station 6 over successive time slots to simplify t processing. The present invention is directed to the use of various packet sizes for various su improve the overall transmission efficiency.

VI. Forward Link Architecture

[0080] In the exemplary embodiment, base station 4 transmits at the maximum power available to base station 4 and at the maximum data rate supported by the data communication system to a single mobile station 6 The maximum data rate that can be supported is dynamic and depends on the C/I of the forward link s by mobile station 6. Preferably, base station 4 transmits to only one mobile station 6 at any given time slot.

[0081] To facilitate data transmission, the forward link comprises four time multiplexed channels power control channel, control channel, and traffic channel. The function and implementation of ea are described below. In the exemplary embodiment, the traffic and power control channels each com of orthogonally spread Walsh channels. In the present invention, the traffic channel is used to t paging messages to mobile station 6. When used to transmit paging messages, the traffic channel is also r as the control channel in this specification.

[0082] In the exemplary embodiment, the bandwidth of the forward link is selected to be 1.2288 MHz selection allows the use of existing hardware components designed for a CDMA system which conform 95 standard. However, the data communication system of the present invention can be adopted for us bandwidths to improve capacity and/or to conform to system requirements. For example, a 5 MHz ba utilized to increase the capacity. Furthermore, the bandwidths of the forward link and the revers (e.g., 5 MHz bandwidth on the forward link and 1.2288 MHz bandwidth on the reverse link) to more capacity with demand.

[0083] In the exemplary embodiment, the short PN_I and PN_Q codes are the same length 2^{15} PN codes which are specified by the IS-95 standard. At the 1.2288 MHz chip rate, the short PN sequences repeat every 26.67 msec = $\{2^{15}/1.2288 \cdot 10^6\}$. In the exemplary embodiment, the same short PN codes are used by all base stations 4 within the data communication system. However, each base station 4 is identified by a unique offset of the basic sh sequences. In the exemplary embodiment, the offset is in increments of 64 chips. Other bandwidth be utilized and are within the scope of the present invention.

VII. Forward Link Traffic Channel

[0084] A block diagram of the exemplary forward link architecture of the present invention is sho

data is partitioned into data packets and provided to CRC encoder 112. For each data packet, CRC encoder 112 generates frame check bits (e.g., the CRC parity bits) and inserts the code tail bits. The forma encoder 112 comprises the data, the frame check and code tail bits, and other overhead bits which are The formatted packet is provided to encoder 114 which, in the exemplary embodiment, encodes the packet in accord with the encoding format disclosed in the aforementioned U.S. Patent Application Serial No. 08/743, formats can also be used and are within the scope of the present invention. The encoded packet from encoder 114 is provided to interleaver 116 which reorders the code symbols in the packet. The interleaved packet is prov puncture element 118 which removes a fraction of the packet in the manner described below. The punctur provided to multiplier 120 which scrambles the data with the scrambling sequence from scrambler 122. Puncture element 118 and scrambler 122 are described in detail below. The output from multiplier 120 comprises the scrambled packet.

[0085] The scrambled packet is provided to variable rate controller 130 which demultiplexes the packet into K parall inphase and quadrature channels, where K is dependent on the data rate. In the exemplary embodiment packet is first demultiplexed into the inphase (I) and quadrature (Q) streams. In the exemplary emb comprises even indexed symbols and the Q stream comprises odd indexed symbol. Each stream is further into K parallel channels such that the symbol rate of each channel is fixed for all data rates. stream are provided to Walsh cover element 132 which covers each channel with a Walsh function to provide orth channels. The orthogonal channel data are provided to gain element 134 which scales the data to maintain a constan total energy-per-chip (and hence constant output power) for all data rates. The scaled data from gain element 134 is provided to multiplexer (MUX) 160 which multiplexes the data with the preamble. The preamble is discussed below. The output from MUX 160 is provided to multiplexer (MUX) 162 which multiplexes the traffic data, the pow control bits, and the pilot data. The output of MUX 162 comprises the I Walsh channels and the Q Walsh channels.

[0086] A block diagram of the exemplary modulator used to modulate the data is illustrated in FIG channels and Q Walsh channels are provided to summers 212a and 212b, respectively, which sum the K Walsh channels to provide the signals I_{sum} and Q_{sum}, respectively. The I_{sum} and Q_{sum} signals are provided to complex multiplier 214. Complex multiplier 214 also receives the PN_I and PN_Q signals from multipliers 236a and 236b, respectively, and multiplies the two complex inputs in accordance with the following equation:

$$\begin{aligned}(I_{mult}+jQ_{mult}) &= (I_{sum}+jQ_{sum})\bullet(PN\_I+jPN\_Q)\\ &= (I_{sum}\bullet PN\_I-Q_{sum}\bullet PN\_Q)+j(I_{sum}\bullet PN\_Q+Q_{sum}\bullet PN\_I)\end{aligned}\quad , \tag{2}$$

where I_{mult} and Q_{mult} are the outputs from complex multiplier 214 and j is the complex representation. The I_{mult} and Q_{mult} signals are provided to filters 216a and 216b, respectively, which filters the signals. The filtered signals from filters 216a and 216b are provided to multipliers 218a and 218b, respectively, which multiplies the signals with the inphase COS ($w_c t$) and the quadrature sinusoid SIN ($w_c t$), respectively. The I modulated and Q modulated signals are p to summer 220 which sums the signals to provide the forward modulated waveform S(t).

[0087] In the exemplary embodiment, the data packet is spread with the long PN code and the short long PN code scrambles the packet such that only the mobile station 6 for which the packet is destined is able descramble the packet. In the exemplary embodiment, the pilot and power control bits and the cont are spread with the short PN codes but not the long PN code to allow all mobile stations 6 to receive these bits. The long PN sequence is generated by long code generator 232 and provided to multiplexer (MUX) 234. The long PN mask determines the offset of the long PN sequence and is uniquely assigned to the destination mobile station 6. The output from MUX 234 is the long PN sequence during the data portion of the transmission and zero otherwise pilot and power control portion). The gated long PN sequence from MUX 234 and the short PN_I and PN_Q sequences from short code generator 238 are provided to multipliers 236a and 236b, respectively, which multiply the two sets sequences to form the PN_I and PN_Q signals, respectively. The PN_I and PN_Q signals are provided to complex multiplier 214.

[0088] The block diagram of the exemplary traffic channel shown in FIGS. 3A and 3B is one of numerou which support data encoding and modulation on the forward link. Other architectures, such as the forward link traffic channel in the CDMA system which conforms to the IS-95 standard, can also be utilized and are with the scope of the present invention.

[0089] In the exemplary embodiment which is not part of the invention, the data rates supported by base station 4 are predetermined and each supported data rate is assigned a unique rate index. Mobile station 6 selects one of the supported data rates based on the C/I measurement. Since the requested data rate needs to be sent 4 to direct that base station 4 to transmit data at the requested data rate, a trade off is made between t supported data rates and the number of bits needed to identify the requested data rate. In the exe

the number of supported data rates is seven and a 3-bit rate index is used to identify the requested data r exemplary definition of the supported data rates is illustrated in Table 1. Different definition o can be contemplated and are within the scope of the present embodiment.

[0090] In the exemplary embodiment which is not part of the invention, the minimum data rate is 3 maximum data rate is 2.4576 Mbps. The minimum data rate is selected based on the worse case C/I m the system, the processing gain of the system, the design of the error correcting codes, and the formance. In the exemplary embodiment, the supported data rates are chosen such that the differen cessive supported data rates is 3 dB. The 3 dB increment is a compromise among several factors w accuracy of the C/I measurement that can be achieved by mobile station 6, the losses (or inefficiencies) which res from the quantization of the data rates based on the C/I measurement, and the number of bits (or to transmit the requested data rate from mobile station 6 to base station 4. More supported data rates requires more bits to identify the requested data rate but allows for more efficient use of the forward link becau error between the calculated maximum data rate and the supported data rate. The present embodimen the use of any number of supported data rates and other data rates than those listed in Table 1.

Table 1 - Traffic Channel Parameters

Parameter	Data Rates							Units
	38.4	76.8	153.6	307.2	614.4	1228.8	2457.6	Kbps
Data bits/packet	1024	1024	1024	1024	1024	2048	2048	bits
Packet length	26.67	13.33	6.67	3.33	1.67	1.67	0.83	msec
Slots/packet	16	8	4	2	1	1	0.5	slots
Packets/transmission	1	1	1	1	1	1	2	packets
Slots/transmission	16	8	4	2	1	1	1	slots
Walsh symbol rate	153.6	307.2	614.4	1228.8	2457.6	2457.6	4915.2	Ksps
Walsh channel/ QPSK phase	1	2	4	8	16	16	16	channels
Modulator rate	76.8	76.8	76.8	76.8	76.8	76.8 [1]	76.8	ksps
PN chips/data bit	32	16	8	4	2	1	0.5	chips/bit
PN chip rate	1228.8	1228.8	1228.8	1228.8	1228.8	1228.8	1228.8	Kcps
Modulation format	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QAM [1]	
Rate index	0	1	2	3	4	5	6	
Note: (1) 16-QAM modulation								

[0091] A diagram of the exemplary forward link frame structure of the present invention is illustr traffic channel transmission is partitioned into frames which, in the exemplary embodiment, are de the short PN sequences or 26.67 msec. Each frame can carry control channel information addresse stations 6 (control channel frame), traffic data addressed to a particular mobile station 6 (traffic frame), or can be empty (idle frame). The content of each frame is determined by the scheduling performed by 4 the transmit In the exemplary embodiment, each frame comprises 16 time slots, with each time slot having a durat A time slot of 1.667 msec is adequate to enable mobile station 6 to perform the C/I measurement of the forward li signal. A time slot of 1.667 msec also represents a sufficient amount of time for efficient packe the exemplary embodiment, each time slot is further partitioned into four quarter slots.

[0092] In the present invention, each data packet is transmitted over one or more time slots as sh the exemplary embodiment, each forward link data packet comprises 1024 or 2048 bits. Thus, the num required to transmit each data packet is dependent on the data rate and ranges from 16 time slot rate to 1 time slot for the 1.2288 Mbps rate and higher.

[0093] An exemplary diagram of the forward link slot structure of the present invention is shown exemplary embodiment, each slot comprises three of the four time multiplexed channels, the traffic channel, the pilot channel, and the power control channel. In the exemplary embodiment, the pilot channels are transmitted in two pilot and power control bursts which are located at the same posit The pilot and power control bursts are described in detail below.

[0094] In the exemplary embodiment, the interleaved packet from interleaver 116 is punctured to accommodate the pilot and power control bursts. In the exemplary embodiment, each interleaved packet comprises 40 and the first 512 code symbols are punctured, as shown in FIG. 4D. The remaining code symbols are to align to the traffic channel transmission intervals.

[0095] The punctured code symbols are scrambled to randomize the data prior to applying the orth cover. The randomization limits the peak-to-average envelope on the modulated waveform S(t). The scrambling sequence can be generated with a linear feedback shift register, in a manner known in the art. In the ex scrambler 122 is loaded with the LC state at the start of each slot. In the exemplary embodiment, the 122 is synchronous with the clock of interleaver 116 but is stalled during the pilot and power control bursts.

[0096] In the exemplary embodiment, the forward Walsh channels (for the traffic channel and power c are orthogonally spread with 16-bit Walsh covers at the fixed chip rate of 1.2288 Mcps. The number of parall channels K per inphase and quadrature signal is a function of the data rate, as shown in Table embodiment, for lower data rates, the inphase and quadrature Walsh covers are chosen to be orthogona cross-talk to the demodulator phase estimate errors. For example, for 16 Walsh channels, an exemplar ment is W_0 through W_7 for the inphase signal and W_8 through W_{15} for the quadrature signal.

[0097] In the exemplary embodiment, QPSK modulation is used for data rates of 1.2288 Mbps and lowe modulation, each Walsh channel comprises one bit. In the exemplary embodiment, at the highest dat Mbps, 16-QAM is used and the scrambled data is demultiplexed into 32 parallel streams which are each 1-bit wide, 16 parallel streams for the inphase signal and 16 parallel streams for the quadrature signal. In the e the LSB of each 2-bit symbol is the earlier symbol output from interleaver 116. In the exemplary embodiment, the QAM modulation inputs of (0, 1, 3, 2) map to modulation values of (+3, +1, −1, −3), respectively. The schemes, such as m-ary phase shift keying PSK, can be contemplated and are within the scope of the pres

[0098] The inphase and quadrature Walsh channels are scaled prior to modulation to maintain a consta power which is independent of the data rate. The gain settings are normalized to a unity referen modulated BPSK. The normalized channel gains G as a function of the number of Walsh channels (or shown in Table 2. Also listed in Table 2 is the average power per Walsh channel (inphase or quadra total normalized power is equal to unity. Note that the channel gain for 16-QAM accounts for the fact that the normalized energy per Walsh chip is 1 for QPSK and 5 for 16-QAM.

Table 2 -Traffic Channel Orthogonal Channel Gains

	Puncture Duration			
Data Rate (Kbps)	Number of Walsh Channels K	Modulation	Walsh Channel Gain G	Average Power per Channel P_k
38.4	1	QPSK	1/2	1/2
76.8	2	QPSK	1/2	1/4
153.6	4	QPSK	1/22	1/8
307.2	8	QPSK	1/4	1/16
614.4	16	QPSK	1/42	1/32
1228.8	16	QPSK	1/42	1/32
2457.6	16	16-QAM	1/4 10	1/32

[0099] In the present invention, a preamble is punctured into each traffic frame to assist mobile station 6 in the synchronization with the first slot of each variable rate transmission. In the exemplary embodimen all-zero sequence which, for a traffic frame, is spread with the long PN code but, for a control spread with the long PN code. In the exemplary embodiment, the preamble is unmodulated BPSK which i spread with Walsh cover W_1. The use of a single orthogonal channel minimizes the peak-to-average envelope. Also, the use of a non-zero Walsh cover W_1 minimizes false pilot detection since, for traffic frames, the pilo Walsh cover W_0 and both the pilot and the preamble are not spread with the long PN code.

[0100] The preamble is multiplexed into the traffic channel stream at the start of the packet for function of the data rate. The length of the preamble is such that the preamble overhead is appro all data rates while minimizing the probability of false detection. A summary of the preamble as a is shown in Table 3. Note that the preamble comprises 3.1 percent or less of a data packet.

Table 3 - Preamble Parameters

	Preamble Puncture Duration		
Data Rate (Kbps)	Walsh Symbols	PN chips	Overhead
38.4	32	512	1.6%
76.8	16	256	1.6%
153.6	8	128	1.6%
307.2	4	64	1.6%
614.4	3	48	2.3%
1228.8	4	64	3.1%
2457.6	2	32	3.1%

VIII. Forward Link Traffic Frame Format

[0101] In the exemplary embodiment, each data packet is formatted by the additions of frame check bits, and other control fields. In this specification, an octet is defined as 8 information bits ar and comprises 8 informat on bits.

[0102] In the exemplary embodiment, the forward link supports two data packet formats which are il 4E and 4F. Packet format 410 comprises five fields and packet format 430 comprises nine fields. Packet format 410 is used when the data packet to be transmitted to mobile station 6 contains enough data to complete octets in DATA field 418. If the amount of data to be transmitted is less than the available octets in DATA field 418, packet format 430 is used. The unused octets are padded with all zeros and designated as PADDING field 446.

[0103] In the exemplary embodiment, frame check sequence (FCS) fields 412 and 432 contain the CRC parity bits which are generated by CRC generator 112 (see FIG. 3A) in accordance with a predetermined generator polyn In the exemplary embodiment, the CRC polynomial is $g(x) = x^{16} + x^{12} + x^{5} + 1$, although other polynomials can be used and are within the scope of the present invention. In the exemplary embodiment, the CRC bits are FMT, SEQ, LEN, DATA, and PADDING fields. This provides error detection over all bits, except the co fields 420 and 448, transmitted over the traffic channel on the forward link. In the alternative embodi are calculated only over the DATA field. In the exemplary embodiment, FCS fields 412 and 432 contain 16 CRC parity bits, although other CRC generators providing different number of parity bits can be used and are the present invention. Although FCS fields 412 and 432 of the present invention has been described in the cont CRC parity bits, other frame check sequences can be used and are within the scope of the presen example, a check sum can be calculated for the packet and provided in the FCS field.

[0104] In the exemplary embodiment, frame format (FMT) fields 414 and 434 contain one control bit which indicate whether the data frame contains only data octets (packet format 410) or data and padding octets and zero or more messages (packet format 430). In the exemplary embodiment, a low value for FMT field 414 corresponds to packet format 410. Alternatively, a high value for FMT field 434 corresponds to packet format 430.

[0105] Sequence number (SEQ) fields 416 and 442 identify the first data unit in data fields 418 and 444, respectively. The sequence number allows data to be transmitted out of sequence to mobile station 6, e.g. for retransmission of packets which have been received in error. The assignment of the sequence number at the data unit the need for frame fragmentation protocol for retransmission. The sequence number also allows mobile station 6 to detect duplicate data units. Upon receipt of the FMT, SEQ, and LEN fields, mobile station 6 is able to determine which data units have been received at each time slot without the use of special signaling messages.

[0106] The number of bits assigned to represent the sequence number is dependent on the maximum num units which can be transmitted in one time slot and the worse case data retransmission delays. In bodiment, each data unit is identified by a 24-bit sequence number. At the 2.4576 Mbps data rate, the maximum num of data units which can be transmitted at each slot is approximately 256. Eight bits are required data units. Furthermore, it can be calculated that the worse case data retransmission delays are The retransmission delays include the time necessary for a NACK message by mobile station 6, retransmission of the data, and the number of retransmission attempts caused by the worse case burst error runs. Therefo mobile station 6 to properly identify the data units being received without ambiguity. The number of 416 and 442 can be increased or decreased, depending on the size of DATA field 418 and the retransmission delays. The use of different number of bits for SEQ fields 416 and 442 are within the scope of the present invention.

[0107] When base station 4 has less data to transmit to mobile station 6 than the space available in DATA field 418, packet format 430 is used. Packet format 430 allows base station 4 to transmit any number of data units, up to maximum number of available data units, to mobile station 6. In the exemplary embodiment, a high value for FMT f 434 indicates that base station 4 is transmitting packet format 430. Within packet format 430, LEN field 440 contains the value of the number of data units being transmitted in that packet. In the exemplary embodime 440 is 8 bits in length since DATA field 444 can range from 0 to 255 octets.

[0108] DATA fields 418 and 444 contain the data to be transmitted to mobile station 6. In the exemplary embodiment, for packet format 410, each data packet comprises 1024 bits of which 992 are data bits. However, variab packets can be used to increase the number of information bits and are within the scope of the pr packet format 430, the size of DATA field 444 is determined by LEN field 440.

[0109] In the exemplary embodiment, packet format 430 can be used to transmit zero or more signaling messag Signaling length (SIG LEN) field 436 contains the length of the subsequent signaling messages, in octets. In t embodiment, SIG LEN field 436 is 8 bits in length. SIGNALING field 438 contains the signaling messages. In the exemplary embodiment, each signaling message comprises a message identification (MESSAGE ID) fiel length (LEN) field, and a message payload, as described below.

[0110] PADDING field 446 contains padding octets which, in the exemplary embodiment, are set to 0 PADDING field 446 is used because base station 4 may have fewer data octets to transmit to mobile station 6 number of octets available in DATA field 418. When this occurs, PADDING field 446 contains enough padding octets to fill the unused data field. PADDING field 446 is variable length and depends on the length of DATA field 444.

[0111] The last field of packet formats 410 and 430 is TAIL fields 420 and 448, respectively. TAIL fields 420 and 448 contain the zero (0x0) code tail bits which are used to force encoder 114 (see FIG. 3A) into a known state at the end each data packet. The code tail bits allow encoder 114 to succinctly partition the packet such that only bits packet are used in the encoding process. The code tail bits also allow the decoder within mobile station 6 to determine the packet boundaries during the decoding process. The number of bits in TAIL fields 420 and 448 depends on the design of encoder 114. In the exemplary embodiment, TAIL fields 420 and 448 are long enough to force encoder 114 to a known state.

[0112] The two packet formats described above are exemplary formats which can be used to facilita of data and signaling messages. Various other packet formats can be create to meet the needs of a nication system. Also, a communication system can be designed to accommodate more than the two pa described above.

IX. Forward Link Control Channel Frame

[0113] In the present invention, the traffic channel is also used to transmit messages from base station 4 to mobile stations 6. The types of messages transmitted include: (1) handoff direction messages, (2) paging me page a specific mobile station 6 that there is data in the queue for that mobile station 6, (3) short data packets for a specific mobile station 6, and (4) ACK or NACK messages for the reverse link data transmissions (to be des herein). Other types of messages can also be transmitted on the control channel and are within the invention. Upon completion of the call set up stage, mobile station 6 monitors the control channel for paging message and begins transmission of the reverse link pilot signal.

[0114] In the exemplary embodiment, the control channel is time multiplexed with the traffic data o as shown in FIG. 4A. Mobile stations 6 identify the control message by detecting a preamble which as been with a predetermined PN code. In the exemplary embodiment, the control messages are transmitted at is determined by mobile station 6 during acquisition. In the preferred embodiment, the data rate of the co is 76.8 Kbps.

[0115] The control channel transmits messages in control channel capsules. The diagram of an exem channel capsule is shown in FIG. 4G. In the exemplary embodiment, each capsule comprises preamble 462, the control payload, and CRC parity bits 474. The control payload comprises one or more messages and, if necessary, bits 472. Each message comprises message identifier (MSG ID) 464, message length (LEN) 466, optional address (ADDR) 468 (e.g., if the message is directed to a specific mobile station 6), and message payload 470. In the exemplary embodiment, the messages are aligned to octet boundaries. The exemplary control channel capsule il 4G comprises two broadcast messages intended for all mobile stations 6 and one message directed at a specific mobile station 6. MSG ID field 464 determines whether or not the message requires an address field (e.g. whe broadcast or a specific message).

X. Forward Link Pilot Channel

[0116] In the present invention, a forward link pilot channel provides a pilot signal which is use 6

for initial acquisition, phase recovery, timing recovery, and ratio combining. These uses are simi communication systems which conform to IS-95 standard. In the exemplary embodiment, the pilot signal is a by mobile stations 6 to perform the C/I measurement.

[0117] The exemplary block diagram of the forward link pilot channel of the present invention is The pilot data comprises a sequence of all zeros (or all ones) which is provided to multiplier 156. Multiplier 156 covers the pilot data with Walsh code W_0. Since Walsh code W_0 is a sequence of all zeros, the output of multiplier 156 is the pilot data. The pilot data is time multiplexed by MUX 162 and provided to the I Walsh channel which is spread by short PN_I code within complex multiplier 214 (see FIG. 3B). In the exemplary embodiment, the pilot data is no with the long PN code, which is gated off during the pilot burst by MUX 234, to allow reception by all mobile stations 6. The pilot signal is thus an unmodulated BPSK signal.

[0118] A diagram illustrating the pilot signal is shown in FIG. 4B. In the exemplary embodiment, each two pilot bursts 306a and 306b which occur at the end of the first and third quarters of the time slot embodiment, each pilot burst 306 is 64 chips in duration (Tp=64 chips). In the absence of traffic data or data, base station 4 only transmits the pilot and power control bursts, resulting in a discontinuous wa the periodic rate of 1200 Hz. The pilot modulation parameters are tabulated in Table 4.

XI. Reverse Link Power Control

[0119] In the present invention, the forward link power control channel is used to send the power which is used to control the transmit power of the reverse link transmission from remote station 6. On the reverse link, each transmitting mobile station 6 acts as a source of interference to all other mobile stations 6 in the network. To minimize interference on the reverse link and maximize capacity, the transmit power of each mobile s by two power control loops. In the exemplary embodiment, the power control loops are similar to system disclosed in detail in U.S. Patent No. 5,056,109, entitled "METHOD AND APPARATUS FOR CONTR TRANSMISSION POWER IN A CDMA CELLULAR MOBILE TELEPHONE SYSTEM", assigned to the assignee of the present invention. Other power control mechanism can also be contemplated and are within the scop invention.

[0120] The first power control loop adjusts the transmit power of mobile station 6 such that the reverse link signal quality is maintained at a set level. The signal quality is measured as the energy-per-bit-to-noise-plus-interference ratio E_b/I_o of the reverse link signal received at base station 4. The set level is referred to as the E_b/I_o set point. The second power control loop adjusts the set point such that the desired level of performance, as measured error- rate (FER), is maintained. Power control is critical on the reverse link because the transmit power 6 is an interference to other mobile stations 6 in the communication system. Minimizing the reverse link transmi reduces the interference and increases the reverse link capacity.

[0121] Within the first power control loop, the E_b/I_o of the reverse link signal is measured at base station 4. Base station 4 then compares the measured E_b/I_o with the set point. If the measured E_b/I_o is greater than the set point, base stat 4 transmits a power control message to mobile station 6 to decrease the transmit power. Alternatively, if the me E_b/I_o is below the set point, base station 4 transmits a power control message to mobile station 6 to increase the transmit power. In the exemplary embodiment, the power control message is implemented with one power cont exemplary embodiment, a high value for the power control bit commands mobile station 6 to increase its transmit power and a low value commands mobile station 6 to decrease its transmit power.

[0122] In the present invention, the power control bits for all mobile stations 6 in communication with each base station 4 are transmitted on the power control channel. In the exemplary embodiment, the power control cha to 32 orthogonal channels which are spread with the 16-bit Walsh covers. Each Walsh channel transmits one rever power control (RPC) bit or one FAC bit at periodic intervals. Each active mobile station 6 is assigned an RPC index which defines the Walsh cover and QPSK modulation phase (e.g. inphase or quadrature) for transmis bit stream destined for that mobile station 6. In the exemplary embodiment, the RPC index of 0 is reserved for the

[0123] The exemplary block diagram of the power control channel is shown in FIG. 3A. The RPC bits symbol repeater 150 which repeats each RPC bit a predetermined number of times. The repeated RPC bits a to Walsh cover element 152 which covers the bits with the Walsh covers corresponding to the RPC indices. bits are provided to gain element 154 which scales the bits prior to modulation so as to maintain a constant power. In the exemplary embodiment, the gains of the RPC Walsh channels are normalized so that the t power is equal to the total available transmit power. The gains of the Walsh channels can be varied for efficient utilization of the total base station transmit power while maintaining reliable RPC mobile stations 6. In the exemplary embodiment, the Walsh channel gains of inactive mobile stations 6 are set to zero. Automatic power control of the RPC Walsh channels is possible using estimates of the forward link q from the corresponding DRC channel from mobile stations 6. The scaled RPC bits from gain element 154 are provided to MUX162.

[0124] In the exemplary embodiment, the RPC indices of 0 through 15 are assigned to Walsh covers W_0 through W_{15}, respectively, and are transmitted around the first pilot burst within a slot (RPC bursts 304 in FIG. 4C). The RPC indices of 16 through 31 are assigned to Walsh covers W_0 through W_{15}, respectively, and are transmitted around the sec pilot burst within a slot (RPC bursts 308 in FIG. 4C). In the exemplary embodiment, the RPC bits are BPSK modu with the even Walsh covers (e.g., W_0, W_2, W_4, etc.) modulated on the inphase signal and the odd Walsh covers W_1, W_3, W_5, etc.) modulated on the quadrature signal. To reduce the peak-to-average envelope, it is preferable to balance the inphase and quadrature power. Furthermore, to minimize crosstalk due to demodulator phase estimate error, it is preferable to assign orthogonal covers to the inphase and quadrature signals.

[0125] In the exemplary embodiment, up to 31 RPC bits can be transmitted on 31 RPC Walsh channels slot. In the exemplary embodiment, 15 RPC bits are transmitted on the first half slot and 16 RPC b the second half slot. The RPC bits are combined by summers 212 (see FIG. 3B) and the composite waveform of the power control channel is as shown is in FIG. 4C.

[0126] A timing diagram of the power control channel is illustrated in FIG. 4B. In the exemplary em bit rate is 600 bps, or one RPC bit per time slot. Each RPC bit is time multiplexed and transmitte (e.g., RPC bursts 304a and 304b), as shown in FIGS. 4B and 4C. In the exemplary embodiment, each RPC burs PN chips (or 2 Walsh symbols) in width (Tpc=32 chips) and the total width of each RPC bit is 64 P symbols). Other RPC bit rates can be obtained by changing the number of symbol repetition. For exa rate of 1200 bps (to support up to 63 **mobile stations** 6 simultaneously or to increase the power control rate) c obtained by transmitting the first set of 31 RPC bits on RPC bursts 304a and 304b and the second set of 32 RPC bits on RPC bursts 308a and 308b. In this case, all Walsh covers are used in the inphase and quadrature modulation parameters for the RPC bits are summarized in Table 4.

Table 4 - Pilot and Power Control Modulation Parameters

Parameter	RPC	FAC	Pilot	Units
Rate	600	75	1200	Hz
Modulation format	QPSK	QPSK	BPSK	
Duration of control bit	64	1024	64	PN chips
Repeat	4	64	4	symbols

[0127] The power control channel has a bursty nature since the number of mobile stations 6 in communication with each base station 4 can be less than the number of available RPC Walsh channels. In this situation, so channels are set to zero by proper adjustment of the gains of gain element 154.

[0128] In the exemplary embodiment, the RPC bits are transmitted to mobile stations 6 without coding or interleaving to minimize processing delays. Furthermore, the erroneous reception of the power control bit is n data communication system of the present invention since the error can be corrected in the next ti control loop.

[0129] In the present invention, mobile stations 6 can be in soft handoff with multiple base stations 4 on the reverse link. The method and apparatus for the reverse link power control for mobile station 6 in soft handoff is disclosed in the aforementioned U.S. Patent No. 5,056,109. Mobile station 6 in soft handoff monitors the RPC Walsh channel for e base station 4 in the active set and combines the RPC bits in accordance with the method disclosed in the U.S. Patent No. 5,056,109. In the first embodiment, mobile station 6 performs the logic OR of the down power commands. Mobile station 6 decreases the transmit power if any one of the received RPC bits commands mobile station 6 to decrease the transmit power. In the second embodiment, mobile station 6 in soft handoff can combine the soft decisions of RPC bits before making a hard decision. Other embodiments for processing the received RPC bits can and are within the scope of the present invention.

[0130] In the present invention, the FAC bit indicates to mobile stations 6 whether or not the traffic channel of t associated pilot channel will be transmitting on the next half frame. The use of the FAC bit impro mobile stations 6, and hence the data rate request, by broadcasting the knowledge of the interference exemplary embodiment, the FAC bit only changes at half frame boundaries and is repeated for eight slots, resulting in a bit rate of 75 bps. The parameters for the FAC bit is listed in Table 4.

[0131] Using the FAC bit, mobile stations 6 can compute the C/I measurement as follows:

$$\left(\frac{C}{I}\right)_i = \frac{C_i}{I - \sum_{j \neq i}\left(1-\alpha_j\right)C_j} \quad , \qquad (3)$$

where $(C/I)_i$ is the C/I measurement of the i^{th} forward link signal, C_i is the total received power of the i^{th} forward link signal, C_j is the received power of the j^{th} forward link signal, I is the total interference if all base stations are transmitting, a_j is the FAC bit of the j^{th} forward link signal and can be 0 or 1 depending on the FAC bit.

XII. Reverse Link Data Transmission

[0132] In the present invention, the reverse link supports variable rate data transmission. The va flexibility and allows mobile station 6 to transmit at one of several data rates, depending on the amount of transmitted to base station 4. In the exemplary embodiment, mobile station 6 can transmit data at the lowest data rat at any time. In the exemplary embodiment, data transmission at higher data rates requires a grant This implementation minimizes the reverse link transmission delay while providing efficient utiliz resource.

[0133] An exemplary illustration of the flow diagram of the reverse link data transmission of the shown in FIG. 8. Initially, at slot n, mobile station 6 performs an access probe, as described in the aforementioned Patent No. 5,289,527, to establish the lowest rate data channel on the reverse link at block 802. I station 4 demodulates the access probe and receives the access message at block 804. Base station 4 grants the request for the data channel and, at slot n+2, transmits the grant and the assigned RPC index on at block 806. At slot n+2, mobile station 6 receives the grant and is power controlled by base station 4, at block 808. Beginning at slot n+3, mobile station 6 starts transmitting the pilot signal and has immediate access to the data channel on the reverse link.

[0134] If mobile station 6 has traffic data and requires a high rate data channel, mobile station 6 can initiate the request at block 810. At slot n+3, base station 4 receives the high speed data request at block 812. At slot n+5, base station 4 transmits the grant on the control channel at block 814. At slot n+5, mobile station 6 receives the grant at block 816 and begins high speed data transmission on the reverse link starting at slot n+6, at block 818.

XIII. Reverse Link Architecture

[0135] In the data communication system of the present invention, the reverse link transmission diff link transmission in several ways. On the forward link, data transmission typically occurs from one base station 4 to one mobile station 6. However, on the reverse link, each base station 4 can concurrently receive data transmissions fr multiple mobile stations 6. In the exemplary embodiment, each mobile station 6 can transmit at one of several data rate depending on the amount of data to be transmitted to base station 4. This system design reflects the asymmetric characteristic of data communication.

[0136] In the exemplary embodiment, the time base unit on the reverse link is identical to the ti forward link. In the exemplary embodiment, the forward link and reverse link data transmissions c which are 1.667 msec in duration. However, since data transmission on the reverse link typically o rate, a longer time base unit can be used to improve efficiency.

[0137] In the exemplary embodiment, the reverse link supports two channels : the pilot/DRC channe channel. The function and implementation of each of these channel are described below. The pilot/DR to transmit the pilot signal and the DRC messages and the data channel is used to transmit traffic

[0138] A diagram of the exemplary reverse link frame structure of the present invention is illustra exemplary embodiment, the reverse link frame structure is similar to the forward link frame struct However, on the reverse link, the pilot/DRC data and traffic data are transmitted concurrently quadrature channels.

[0139] In the exemplary embodiment, mobile station 6 transmits a DRC message on the pilot/DRC channel at eac time slot whenever mobile station 6 is receiving high speed data transmission. Alternatively, when mobile station 6 is not receiving high speed data transmission, the entire slot on the pilot/DRC channel comprises the signal is used by the receiving base station 4 for a number of functions : as an aid to initial acquisition, reference for the pilot/DRC and the data channels, and as the source for the closed loop reverse l

[0140] In the exemplary embodiment, the bandwidth of the reverse link is selected to be 1.2288 MHz. selection allows the use of existing hardware designed for a CDMA system which conforms to the IS-95 standard. However, other bandwidths can be utilized to increase capacity and/or to conform to system requir

emplary embodiment, the same long PN code and short PN_I and PN_Q codes as those specified by the IS-95 standard are used to spread the reverse link signal. In the exemplary embodiment, the reverse link channels QPSK modulation. Alternatively, OQPSK modulation can be used to minimize the peak-to-average amplitude variation of the modulated signal which can result in improved performance. The use of different system ban and modulation schemes can be contemplated and are within the scope of the present invention.

[0141] In the exemplary embodiment, the transmit power of the reverse link transmissions on the pi and the data channel are controlled such that the E_b/I_o of the reverse link signal, as measured at base station 4, is maintained at a predetermined E_b/I_o set point as discussed in the aforementioned U.S. Patent No. 5,506,109. control is maintained by base stations 4 in communication with the mobile station 6 and the commands are transmitted as the RPC bits as discussed above.

XIV. Reverse Link Data Channel

[0142] A block diagram of the exemplary reverse link architecture of the present invention is sho data is partitioned into data packets and provided to encoder 612. For each data packet, encoder 612 generates the CRC parity bits, inserts the code tail bits, and encodes the data. In the exemplary embodiment, encoder 612 encodes the packet in accordance with the encoding format disclosed in the aforementioned U.S. Patent App 08/743,688. Other encoding formats can also be used and are within the scope of the present invent packet from encoder 612 is provided to block interleaver 614 which reorders the code symbols in the packet. Th interleaved packet is provided to multiplier 616 which covers the data with the Walsh cover and provides the co data to gain element 618. Gain element 618 scales the data to maintain a constant energy-per-bit E_b regardless of the data rate. The scaled data from gain element 618 is provided to multipliers 650b and 650d which spread the data with the PNQ and PNI sequences, respectively. The spread data from multipliers 650b and 650d are provided to filters 652b and 652d, respectively, which filter the data. The filtered signals from filters 652a and 652b are provided to summer 654a and the filtered signals from filters 652c and 652d are provided to summer 654b. Summers 654 sum the signals from the data channel with the signals from the pilot/DRC channel. The outputs of summers 654a and 654b comprise IOUT and QOUT, respectively, which are modulated with the inphase sinusoid COS(w_ct) and the quadrature sinusoid SIN(w_ct), respectively (as in the forward link), and summed (not shown in FIG. 6). In the exempla traffic data is transmitted on both the inphase and quadrature phase of the sinusoid.

[0143] In the exemplary embodiment, the data is spread with the long PN code and the short PN codes code scrambles the data such that the receiving base station 4 is able to identify the transmitting mobile station 6. The short PN code spreads the signal over the system bandwidth. The long PN sequence is generated by long 642 and provided to multipliers 646. The short PN_I and PN_Q sequences are generated by short code generator 644 and also provided to multipliers 646a and 646b, respectively, which multiply the two sets of sequences to form the I and PN_Q signals, respectively. Timing/control circuit 640 provides the timing reference.

[0144] The exemplary block diagram of the data channel architecture as shown in FIG. 6 is one of tectures which support data encoding and modulation on the reverse link. For high rate data transmis similar to that of the forward link utilizing multiple orthogonal channels can also be used. Othe the architecture for the reverse link traffic channel in the CDMA system which conforms to the IS-95 standard, can also be contemplated and are within the scope of the present invention.

[0145] In the exemplary embodiment, the reverse link data channel supports four data rates which Table 5. Additional data rates and/or different data rates can be supported and are within the invention. In the exemplary embodiment, the packet size for the reverse link is dependent on the in Table 5. As described in the aforementioned U.S. Patent Application Serial No. 08/743,688, imp formance can be obtained for larger packet sizes. Thus, different packet sizes than those listed in to improve performance and are within the scope of the present invention. In addition, the packet parameter which is independent of the data rate.

Table 5 - Pilot and Power Control Modulation Parameters

Parameter	Data rates				Units
	9.6	19.2	38.4	76.8	Kbps
Frame duration	26.66	26.66	13.33	13.33	msec
Data packet length	245	491	491	1003	bits
CRC length	16	16	16	16	bits
Code tail bits	5	5	5	5	bits

(continued)

Parameter	Data rates				Units
Total bits/packet	256	512	512	1024	bits
Encoded packet length	1024	2048	2048	4096	symbols
Walsh symbol length	32	16	8	4	chips
Request required	no	yes	yes	yes	

[0146] As shown in Table 5, the reverse link supports a plurality of data rates. In the exemplar lowest data rate of 9.6K bps is allocated to each mobile station 6 upon registration with base station 4. In the exemplary embodiment, mobile stations 6 can transmit data on the lowest rate data channel at any time slot witho request permission from base station 4. In the exemplary embodiment, data transmission at the higher data granted by the selected base station 4 based on a set of system parameters such as the system loading, fairn total throughput. An exemplary scheduling mechanism for high speed data transmission is describe aforementioned U.S. Patent Application Serial No. 08/798,951.

XV. Reverse Link Pilot/DRC Channel

[0147] The exemplary block diagram of the pilot/DRC channel is shown in FIG. 6. The DRC message i DRC encoder 626 which encodes the message in accordance with a predetermined coding format. Coding o message is important since the error probability of the DRC message needs to be sufficiently low forward link data rate determination impacts the system throughput performance. In the exemplary e encoder 626 is a rate (8,4) CRC block encoder which encodes the 3-bit DRC message into an 8-bit code word. The encoded DRC message is provided to multiplier 628 which covers the message with the Walsh code which unique identifies the destination base station 4 for which the DRC message is directed. The Walsh code is provided by generator 624. The covered DRC message is provided to multiplexer (MUX) 630 which multiplexes the message with the pilot data. The DRC message and the pilot data are provided to multipliers 650a and 650b which spread the data with the PN_I and PN_Q signals, respectively. Thus, the pilot and DRC message are transmitted on both and quadrature phase of the sinusoid.

[0148] In the exemplary embodiment, the DRC message is transmitted to the selected base station 4. This is achieved by covering the DRC message with the Walsh code which identifies the selected base station 4. In the exemplary embodiment, the Walsh code is 128 chips in length. The derivation of 128-chip Walsh codes are known in the art. One unique Walsh code is assigned to each base station 4 which is in communication with mobile station 6. Each base station 4 decovers the signal on the DRC channel with its assigned Walsh code. The selected base station 4 is able to decover the DRC message and transmits data to the requesting mobile station 6 on the forward link in response thereto. Oth base stations 4 are able to determine that the requested data rate is not directed to them because the 4 are assigned different Walsh codes.

[0149] In the exemplary embodiment, the reverse link short PN codes for all base stations 4 in the data communication system is the same and there is no offset in the short PN sequences to distinguish the different base 4. The data communication system of the present invention supports soft handoff on the reverse link. Using t codes with no offset allows multiple base stations 4 to receive the same reverse link transmission from mobile 6 during a soft handoff. The short PN codes provide spectral spreading but do not allow for identific

[0150] In the exemplary embodiment which is not part of the invention, the DRC message carries the rate by mobile station 6. In the alternative embodiment, the DRC message carries an indication of the forw (e.g., the C/I information as measured by mobile station 6). Mobile station 6 can simultaneously receive the forward lin pilot signals from one or more base stations 4 and performs the C/I measurement on each received pilot signal. station 6 then selects the best base station 4 based on a set of parameters which can comprise present and pre C/I measurements. The rate control information is formatted into the DRC message which can be co station 4 in one of several embodiments.

[0151] In the first embodiment which is not part of the invention, mobile station 6 transmits a DRC message based on the requested data rate. The requested data rate is the highest supported data rate which yields sat at the C/I measured by mobile station 6. From the C/I measurement, mobile station 6 first calculates the maximum data rate which yields satisfactory performance. The maximum data rate is then quantized to one of the s and designated as the requested data rate. The data rate index corresponding to the requested data to the selected base station 4. An exemplary set of supported data rates and the corresponding data rate shown in Table 1.

[0152] In the second embodiment, wherein mobile station 6 transmits an indication of the forward link quality selected base station 4, mobile station 6 transmits a C/I index which represents the quantized value of the urement. The C/I measurement can be mapped to a table and associated with a C/I index. Using more b the C/I index allows a finer quantization of the C/I measurement. Also, the mapping can be linear linear mapping, each increment in the C/I index represents a corresponding increase in the C/I example, each step in the C/I index can represent a 2.0 dB increase in the C/I measurement. For a pr each increment in the C/I index can represent a different increase in the C/I measurement. As an exa mapping can be used to quantize the C/I measurement to match the cumulative distribution function C/I distribution as shown in FIG. 10.

[0153] Other embodiments to convey the rate control information from mobile station 6 to base station 4 can be contemplated and are within the scope of the present invention. Furthermore, the use of differe represent the rate control information is also within the scope of the present invention. Througho cation, the present invention is described in the context of the first embodiment which is not pa use of a DRC message to convey the requested data rate, for simplicity.

[0154] In the exemplary embodiment, the C/I measurement can be performed on the forward link pilo manner similar to that used in the CDMA system. A method and apparatus for performing the C/I m disclosed in U.S. Patent Application Serial No. 08/722,763, entitled "METHOD AND APPARATUS FOR MEA LINK QUALITY IN A SPREAD SPECTRUM COMMUNICATION SYSTEM", filed September 27,1996, assigned to the assignee of the present invention. In summary, the C/I measurement on the pilot signal can be obtai the received signal with the short PN codes. The C/I measurement on the pilot signal can contain channel condition changed between the time of the C/I measurement and the time of actual data tra present embodiment, the use of the FAC bit allows mobile station 6 to take into consideration the forward link ac when determining the requested data rate.

[0155] In the alternative embodiment, the C/I measurement can be performed on the forward link tra traffic channel signal is first despread with the long PN code and the short PN codes and decove code. The C/I measurement on the signals on the data channels can be more accurate because a large the transmitted power is allocated for data transmission. Other methods to measure the C/I of the signal by mobile station 6 can also be contemplated and are within the scope of the present invention.

[0156] In the exemplary embodiment which is not part of the invention, the DRC message is transmit of the time slot (see FIG. 7A). For an exemplary time slot of 1.667 msec, the DRC message compris chips or 0.83 msec of the time slot. The remaining 1024 chips of time are used by base station 4 to demodulate and decode the message. Transmission of the DRC message in the earlier portion of the time slot allow decode the DRC message within the same time slot and possibly transmit data at the requested data rat successive time slot. The short processing delay allows the communication system of the present i adopt to changes in the operating environment.

[0157] In the alternative embodiment, the requested data rate is conveyed to base station 4 by the use of an absolute reference and a relative reference. In this embodiment, the absolute reference comprising the req transmitted periodically. The absolute reference allows base station 4 to determine the exact data rate requested b mobile station 6. For each time slots between transmissions of the absolute reference, mobile station 6 transmits a relative reference to base station 4 which indicates whether the requested data rate for the upcoming time sl lower, or the same as the requested data rate for the previous time slot. Periodically, mobile station 6 transmits an absolute reference. Periodic transmission of the data rate index allows the requested data rate state and ensures that erroneous receptions of relative references do not accumulate. The use of a and relative references can reduce the transmission rate of the DRC messages to base station 4. Other protocols to transmit the requested data rate can also be contemplated and are within the scope of the present

XVI. Reverse Link Access Channel

[0158] The access channel is used by mobile station 6 to transmit messages to base station 4 during the registration phase. In the exemplary embodiment, the access channel is implemented using a slotted structure wi accessed at random by mobile station 6. In the exemplary embodiment, the access channel is time multiplexed DRC channel.

[0159] In the exemplary embodiment, the access channel transmits messages in access channel caps exemplary embodiment, the access channel frame format is identical to that specified by the IS-95 standard, except that the timing is in 26.67 msec frames instead of the 20 msec frames specified by the IS-95 standard. The diagram of an exemplary access channel capsule is shown in FIG. 7B. In the exemplary embodiment, each access ch 712 comprises preamble 722, one or more message capsules 724, and padding bits 726. Each message capsule 724 comprises message length (MSG LEN) field 732, message body 734, and CRC parity bits 736.

XVII. Reverse Link NACK Channel

[0160] In the present invention, mobile station 6 transmits the NACK messages on the data channel. The NACK message is generated for each packet received in error by mobile station 6. In the exemplary embodiment, the NACK messages can be transmitted using the Blank and Burst signaling data format as disclosed in the af Patent No. 5,504,773.

[0161] Although the present invention has been described in the context of a NACK protocol, the protocol can be contemplated and are within the scope of the present invention.

[0162] The previous description of the preferred embodiments is provided to enable any person ski make or use the present invention. The various modifications to these embodiments will be readily skilled in the art, and the generic principles defined herein may be applied to other embodiments inventive faculty.

Claims

1. A method of controlling a data rate of a signal transmitted over a wireless channel during a ti station (4) to a mobile station (6), the time frame comprising a plurality of time slots, the r

   receiving a data request message, DRC message, at the base station (4) transmitted from the (6) and contaning an indication of a quality measure of the channel;
   selecting at the base station a data rate that is based on said indication in the received
   transmitting the signal from the base station (4) during the time frame at said data rate, characterized in that
   the indication in the DRC message is based on a pilot signal transmitted through a forward from the base station (4), and the DRC message is received at every time slot at the base s

2. The method of claim 1, wherein the DRC message and traffic data are transmitted concurrently quadrature channels.

3. The method of claim 1, wherein the selecting comprises selecting the data rate from among a pre data rates.

4. The method of claim 1, wherein the selecting comprises selecting a channel coding configuration the data rate during the time frame.

5. The method of claim 1, wherein the selecting comprises selecting a packet format corresponding

6. The method of claim 1, wherein the selecting comprises selecting a quantity of user data corres rate for transmission during the time frame.

7. A base station (4) configured to transmit a signal to a mobile station (6) during a time frame c the time frame comprising a plurality of time slots, the base station (4) comprising:

   means for receiving from the mobile station (6) a data request message, DRC message, containi of a quality measure of the wireless channel;
   means for selecting a data rate that is based on said indication in the received DRC messag
   means for transmitting the signal at said data rate, characterized in that
   the indication in the DRC message is based on a pilot signal transmitted through a forward from the base station (4), an the DRC message is received at every time slot at the base st

8. The base station (4) of claim 7, wherein the DRC message and traffic data are transmitted concu and quadrature channels.

9. The base station (4) of claim 7, wherein the means for selecting comprises means for selecting among a predetermined set of data rates.

10. The base station (4) of claim 7, wherein the means for selecting the data rate comprises mea channel coding configuration corresponding to the data rate.

11. The base station (4) of claim 7, wherein the means for selecting the data rate comprises mea packet format corresponding to the data rate.

12. The base station (4) of claim 7, wherein the means for selecting the data rate comprises mea quantity or user data corresponding to the data rate for transmission during the time frame.

13. The base station (4) of claim 7,
wherein said means for receiving comprises a receiver configured to receive from the mobile message containing an indication of said quality measure of the wireless channel; and
wherein said means for transmitting comprises a transmitter coupled to the receiver and configu signal during said time frame at said data rate that is based on the received DRC message.

14. The base station (4) of claim 13, further comprising a selector element (14) coupled to the recei and configured to select the data rate based on the received DRC message.

15. The base station (4) of claim 14, wherein the selector element (14) is configured to select the a predetermined set of data rates.

16. The base station (4) of claim 14, wherein the selector element (14) is configured to select a c uration for transmission of the signal during the time frame, wherein the selected channel c corresponds to the data rate.

17. The base station (4) of claim 14, wherein the selector element (14) is configured to select transmission of the signal during the time frame, wherein the selected packet format correspon

18. The base station (4) of claim 14, wherein the selector element (14) is configured to select a for transmission of the signal during the time frame, wherein the selected quantity of user da data rate.

19. A method of controlling a data rate of a signal received at a mobile station (6) and transmitte to the mobile station (6) during a time frame over a wireless channel, the time frame comprisi slots, the method comprising:

transmitting, from the mobile station (6), a data request message, DRC message, to the base taining an indication of a quality measure of the wireless channel; and
receiving, at the mobile station (6), the signal at a data rate during the time frame, wherei on the quality measure, characterized in that
the indication in the DRC message is based on a pilot signal transmitted through a forward from the base station (4), and the DRC message is transmitted at every time slot from the m

20. The method of claim 19, wherein the DRC message and traffic data are transmitted concurrently quadrature channels.

21. The method of claim 19, wherein the transmitting comprises transmitting information indicative to-inter-ference ratio for the wireless channel.

22. The method of claim 19, wherein the receiving comprises receiving a packet having a packet for packet format corresponds to the data rate.

23. The method of claim 22, wherein the receiving comprises receiving a packet having a packet for a predefined quantity of coding bits for transmission during the time frame.

24. The method of claim 22, wherein the receiving comprises receiving a packet having a packet for a predefined quantity of user data bits for transmission during the time frame.

25. The method as in claim 19, further comprising:

determining a Carrier-to-Interference (C/I) ratio of data communications received on a forward lin

26. The method as in claim 19, further comprising:

determining a Bit Error Rate (BER) of data communications received on a forward link.

27. The method as in claim 19, further comprising:

determining a Packet Error Rate (PER) of data communications received on a forward link.

28. The method as in claim 19, wherein transmitting the DRC message comprises:

transmitting the DRC message on a dedicated channel on a reverse link.

29. The method as in claim 19, further comprising:

demodulating data communications received on a traffic channel of a forward link in accorda rate; and
decoding data communications received on a traffic channel of a forward link in accordance w

30. The method as in claim 19, further comprising:

retransmitting the DRC message on a reverse link.

31. A mobile station (6) for receiving a signal during a time frame through a wireless channel from time frame comprising a plurality of time slots, the mobile station (6) comprising:

means for transmitting to the base station (4) a data request message, DRC message, containi of a quality measure of the wireless channel; and
means for receiving from the base station (4) the signal at a data rate during the time fra rate is based on the quality measure, characterized in that
the indication in the DRC message is based on a pilot signal transmitted through a forward from the base station (4), and the DRC message is transmitted at every time slot from the m

32. The mobile station (6) of claim 31, wherein the DRC message and traffic data are transmitted conc and quadrature channels.

33. The mobile station (6) of claim 31, wherein the means for transmitting comprises means for trans indicative of a carrier-to-interference ratio for the wireless channel.

34. The mobile station (6) of claim 31, wherein the means for receiving comprises means for dete format of the received signal,
wherein the packet format corresponds to the data rate.

35. The mobile station (6) of claim 31, wherein the means for receiving comprises means for deter coding configuration for decoding the signal, wherein the channel coding configuration correspon

36. The mobile station (6) of claim 31,
wherein said means for transmitting comprise a transmitter configured to transmit to the base message containing an indication of said quality measure of the wireless channel; and
wherein said means for receiving comprise a receiver configured to receive from the base stati said data rate during said time frame, wherein the data rate is based on the quality measure.

37. The mobile station (6) of claim 36, wherein the DRC message containing an indication of a qualit a carrier-to-interference ratio for the wireless channel.

38. The mobile station (6) as in claim 31, further comprising:

means for determining a Carrier-to-Interference (C/I) ratio of data communications received on a for

39. The mobile station (6) as in claim 31, further comprising:

means for determining a Bit Error Rate (BER) of data communications received on a forward l

40. The mobile station (6) as in claim 31, further comprising:

means for determining a Packet Error Rate (PER) of data communications received on a forwar

41. The mobile station (6) as in claim 31, further comprising:

means for transmitting the DRC message on a dedicated channel on a reverse link.

42. The mobile station (6) as in claim 31, further comprising:

means for demodulating data communications received on a traffic channel of a forward link ir the data rate; and
means for decoding data communications received on a traffic channel of a forward link in ac data rate.

Patentanspr che

1. Verfahren zum Steuern einer Datenrate eines Signals, das w hrend eines Zeitfensters ber einen d von einer Basisstation (4) an eine Mobilstation (6) bertragen wird, wobei das Zeitfenster ein schlitzen umfasst, das Verfahren aufweisend:

Empfangen einer Datenanfragenachricht, DRC-Nachricht, bei der Basisstation (4), die von der Mobilsta bertragen wurde und einen Hinweis auf ein Qualit tsma des Kanals enth lt;
Ausw hlen einer Datenrate bei der Basisstation basierend auf dem Hinweis in der empfangenen DRC-Nachricht; bertragen des Signals von der Basisstation (4) w hrend des Zeitfensters mit der Datenrate, dadurch gekennzeichnet, dass
der Hinweis in der DRC-Nachricht auf einem Pilotsignal basiert, das durch einen Vorwärtsverbindungs-Pilotkanal von der Basisstation (4) bertragen wurde, und dass die DRC-Nachricht in jedem Zeitschlitz von der Basisstat (4) empfangen wird.

2. Verfahren nach Anspruch 1, wobei die DRC-Nachricht und Verkehrsdaten gleichzeitig auf einem In-Phase-Kanal und einem Quadratur-Kanal bertragen werden.

3. Verfahren nach Anspruch 1, wobei das Ausw hlen ein Ausw hlen der Datenrate aus einer vorbestimm von Datenraten umfasst.

4. Verfahren nach Anspruch 1, wobei das Ausw hlen ein Ausw hlen einer Kanalkodierungskonfiguration e der Datenrate w hrend des Zeitfensters umfasst.

5. Verfahren nach Anspruch 1, wobei Ausw hlen umfasst Ausw hlen eines Paketformats entsprechend der

6. Verfahren nach Anspruch 1, wobei Ausw hlen umfasst Ausw hlen einer Menge von Anwenderdaten ents der Datenrate zum bertragen w hrend des Zeitfensters.

7. Basisstation (4), konfiguriert zum bertragen eines Signals an eine Mobilstation (6) w hrend ber einen drahtlosen Kanal, wobei das Zeitfenster eine Mehrzahl von Zeitschlitzen umfasst, wobe (4) aufweist:

Mittel zum Empfangen einer Datenanfragenachricht, DRC-Nachricht, von der Mobilstation (6), wobei die DR Nachricht einen Hinweis auf ein Qualit tsma des drahtlosen Kanals enth lt;
Mittel zum Ausw hlen einer Datenrate basierend auf dem Hinweis in der empfangenen DRC-Nachricht; und
Mittel zum bertragen des Signals mit der Datenrate, dadurch gekennzeichnet, dass
die Hinweise in der DRC-Nachricht auf einem Pilotsignal basieren, das durch einen Vorw rtsverb

Pilotkanal von der Basisstation (4) übertragen wurde, und dass die DRC-Nachricht in jedem Zeitschlitz von der Basisstation (4) empfangen wird.

8. Basisstation (4) nach Anspruch 7, wobei die DRC-Nachricht und Verkehrsdaten gleichzeitig auf einem In-Phase-Kanal und einem Quadratur-Kanal übertragen werden.

9. Basisstation (4) nach Anspruch 7, wobei die Mittel zum Auswählen Mittel zum Auswählen der Daten vorbestimmten Menge von Datenraten umfassen.

10. Basisstation (4) nach Anspruch 7, wobei die Mittel zum Auswählen der Datenrate Mittel zum Au Kanalkodierungskonfiguration entsprechend der Datenrate umfassen.

11. Basisstation (4) nach Anspruch 7, wobei die Mittel zum Auswählen der Datenrate Mittel zum Au Paketformats entsprechend der Datenrate umfassen.

12. Basisstation (4) nach Anspruch 7, wobei die Mittel zum Auswählen der Datenrate Mittel zum Auswähl an Anwenderdaten entsprechend der Datenrate zur Übertragung während des Zeitfensters umfassen.

13. Basisstation (4) nach Anspruch 7,
wobei die Mittel zum Empfangen einen Empfänger umfassen, der zum Empfangen der DRC-Nachricht von der Mobilstation konfiguriert ist, wobei DRC-Nachricht einen Hinweis auf das Qualitätsmaß des drahtlosen Kanal hält; und
wobei die Mittel zum Übertragen einen Sender umfassen, der mit dem Empfänger verbunden ist und zu des Signals während des Zeitfensters mit der Datenrate konfiguriert ist, die auf der Nachricht empfangen basiert.

14. Basisstation (4) nach Anspruch 13, weiterhin aufweisend ein Auswahlelement (14), das mit dem E dem Sender verbunden ist und zum Auswählen der Datenrate basierend auf der empfangenen DRC-Nachricht konfiguriert ist.

15. Basisstation (4) nach Anspruch 14, wobei das Auswahlelement (14) zum Auswählen der Datenrate a bestimmten Menge von Datenraten konfiguriert ist.

16. Basisstation (4) nach Anspruch 14, wobei das Auswahlelement (14) zum Auswählen einer Kanalkodi guration zum Übertragen des Signals während des Zeitfensters konfiguriert ist, wobei die ausgew rungskonfiguration der Datenrate entspricht.

17. Basisstation (4) nach Anspruch 14, wobei das Auswahlelement (14) zum Auswählen eines Paketformat tragen des Signals während des Zeitfensters konfiguriert ist, wobei das ausgewählte Paketforma entspricht.

18. Basisstation (4) nach Anspruch 14, wobei das Auswahlelement (14) zum Auswählen einer Menge von daten zur Übertragung des Signals während des Zeitfensters konfiguriert ist, wobei die ausgew Anwenderdaten der Datenrate entspricht.

19. Verfahren zum Steuern einer Datenrate eines Signals, das von einer Mobilstation (6) empfangen wi Basisstation (4) an die Mobilstation (6) während eines Zeitfensters über einen drahtlosen Kana wobei das Zeitfenster eine Mehrzahl von Zeitschlitzen umfasst, das Verfahren aufweisend:

Übertragen einer Datenanfragenachricht, DRC-Nachricht, von der Mobilstation (6) an die Basisstation (4 die DRC-Nachricht einen Hinweis auf ein Qualitätsmaß des drahtlosen Kanals enthält; und
Empfangen des Signals bei der Mobilstation mit einer Datenrate während des Zeitfensters, wobe auf dem Qualitätsmaß basiert, dadurch gekennzeichnet, dass
der Hinweis in der DRC-Nachricht auf einem Pilotsignal basiert, das durch einen Vorwärtsverbindungs-Pilotkanal von der Basisstation (4) übertragen wurde, und wobei die DRC-Nachricht in jedem Zeitschlitz von der Mobilstation (6) übertragen wird.

20. Verfahren nach Anspruch 19, wobei die DRC-Nachricht und Verkehrsdaten gleichzeitig auf einem In-Phase-Kanal

und einem Quadratur-Kanal bertragen werden.

21. Verfahren nach Anspruch 19, wobei das bertragen ein bertragen von Informationen hinweisend au zu-Interferenzverh ltnis f r den drahtlosen Kanal umfasst.

22. Verfahren nach Anspruch 19, wobei das Empfangen ein Empfangen eines Paketes mit einem Paketforma wobei das Paketformat der Datenrate entspricht.

23. Verfahren nach Anspruch 22, wobei das Empfangen ein Empfangen eines Paketes mit einem Paketforma das eine vorbestimmte Menge von Code-Bits zur bertragung w hrend des Zeitfensters umfasst.

24. Verfahren nach Anspruch 22, wobei das Empfangen ein Empfangen eines Paketes mit einem Paketforma das eine vorbestimmt Menge von Anwenderdatenbits zum bertragen w hrend des Zeitfensters umfas

25. Verfahren nach Anspruch 19, weiterhin aufweisend:

Bestimmen eines Tr ger-zu-Interferenzverh ltnisses (C/I) von Datenmitteilungen, die auf einer V bindung empfangen wurden.

26. Verfahren nach Anspruch 19, weiterhin aufweisend:

Bestimmen einer Bit-Fehler-Rate (BER) von Datenmitteilungen, die auf einer Vorw rtsverbindung emp wurden.

27. Verfahren nach Anspruch 19, weiterhin aufweisend:

Bestimmen einer Paket-Fehler-Rate (PER) von Datenmitteilungen, die auf einer Vorw rtsverbindung e gen wurde.

28. Verfahren nach Anspruch 19, wobei das bertragen der DRC-Nachricht umfasst:

bertragen der DRC-Nachricht auf einem bestimmten Kanal auf einer R ckw rtsverbindung.

29. Verfahren nach Anspruch 19, weiterhin aufweisend:

Demodulieren von Datenmitteilungen, die auf einem Verkehrskanal einer Vorw rtsverbindung in mung mit der Datenrate empfangen wurden; und
Decodieren von Datenmitteilungen, die auf einem Verkehrskanal einer Vorw rtsverbindung in be mit der Datenrate empfangen wurden.

30. Verfahren nach Anspruch 19, weiterhin aufweisend:

erneutes bertragen der DRC-Nachricht auf einer R ckw rtsverbindung.

31. Mobilstation (6) zum Empfangen eines Signals w hrend eines Zeitfensters ber einen drahtlosen Basisstation (4) wobei das Zeitfenster eine Mehrzahl von Zeitschlitzen umfasst, wobei die Mobil

Mittel zum bertragen einer Datenanfragenachricht, DRC-Nachricht, an die Basisstation, wobei die DRC-Nachricht einen Hinweis auf ein Qualit tsma des drahtlosen Kanals enth lt; und
Mittel zum Empfangen des Signals mit einer Datenrate w hrend des Zeitfensters von der Basisst die Datenrate auf dem Qualit tsma basiert, dadurch gekennzeichnet, dass
der Hinweis in der DRC-Nachricht auf einem Pilotsignal basiert, das durch einen Vorw rtsverbindungs-Pilotkanal von der Basisstation (4) bertragen wurde und wobei die DRC-Nachricht in jedem Zeitschlitz von der Mobilstat (6) bertragen wird.

32. Mobilstation (6) nach Anspruch 31, wobei die DRC-Nachricht und Verkehrsdaten gleichzeitig auf einem In-Phase-Kanal und einem Quadratur-Kanal bertragen werden.

33. Mobilstation nach Anspruch 31, wobei die Mittel zum bertragen Mittel zum bertragen von Informat die auf ein Tr ger-zu-Interferenzverh ltnis des drahtlosen Kanals hinweisen.

34. Mobilstation (6) nach Anspruch 31, wobei die Mittel zum Empfangen Mittel zum Bestimmen eines P des empfangenen Signals umfassen, wobei das Paketformat der Datenrate entspricht.

35. Mobilstation (6) nach Anspruch 31, wobei die Mittel zum Empfangen Mittel zum Bestimmen einer Kan konfiguration zum Decodieren des Signals umfassen, wobei die Kanalkodierungskonfiguration der spricht.

36. Mobilstation (6) nach Anspruch 31,
wobei die Mittel zum bertragen einen Sender umfassen, der zum bertragen der DRC-Nachricht an die Basisstation konfiguriert ist, wobei die DRC-Nachricht einen Hinweis auf das Qualit tsma des drahtlosen Kanals enth wobei die Mittel zum Empfangen einen Empf nger umfassen, der konfiguriert ist zum Empfangen de der Datenrate w hrend des Zeitfensters von der Basisstation (4), wobei die Datenrate auf dem Qual

37. Mobilstation nach Anspruch 36, wobei die DRC-Nachricht, die einen Hinweis auf ein Qualit tsma enth lt Tr ger-zu-Interferenzverh ltnis des drahtlosen Kanals umfasst.

38. Mobilstation nach Anspruch 31, weiterhin aufweisend:

Mittel zum Bestimmen eines Tr ger-zu-Interferenzverh ltnisses (C/I) von Datenmitteilungen, die auf e w rtsverbindung empfangen wurden.

39. Mobilstation (6) nach Anspruch 31, weiterhin aufweisend:

Mittel zum Bestimmen einer Bit-Fehlerrate (BER) von Datenmitteilungen, die auf einer Vorw rtsverbin empfangen wurden.

40. Mobilstation (6) nach Anspruch 31, weiterhin aufweisend:

Mittel zum Bestimmen einer Paket-Fehlerrate (PER) von Datenmitteilungen, die auf einer Vorw rtsverbin empfangen wurden.

41. Mobilstation (6) nach Anspruch 31, weiterhin aufweisend:

Mittel zur bertragung der DRC-Nachricht auf einem bestimmten Kanal auf einer R ckw rtsverbindung.

42. Mobilstation (6) nach Anspruch 31, weiterhin aufweisend:

Mittel zum Demodulieren von Datenmitteilungen, die auf einem Verkehrskanal einer Vorw rtsv bereinstimmung mit der Datenrate empfangen wurden; und
Mittel zum Decodieren von Datenmitteilungen, die auf einem Verkehrskanal einer Vorw rtsverbi einstimmung mit der Datenrate empfangen wurden.

Revendications

1. Un procØdØ pour contr ler un dØbit de donnØes d un signal Ømis sur un canal sans fil durant une depuis une station de base (4) vers une station mobile (6), la trame temporelle comprenant une pl temporels, le procØdØ comprenant :

recevoir un message de requŒte de donnØes, message DRC,   la station de base (4) Ømis depu mobile (6) et contenant une indication d une mesure de qualitØ du canal ;
sØlectionner le message DRC re u ;
Ømettre le signal depuis la station de base (4) pendant la trame temporelle au dØbit de do caractØrisØ en ce que
l indication dans le message DRC est basØe sur un signal pilote Ømis via un canal pilote de

la station de base (4), et le message DRC est re u   chaque crØneau temporel   la station d

2. Le procØdØ de la revendication 1, dans lequel le message DRC et des donnØes de trafic sont transmi sur des canaux en phase et en quadrature.

3. Le procØdØ de la revendication 1, dans lequel la sØlection comprend la sØlection du dØbit de ensemble prØdØterminØ de dØbits de donnØes.

4. Le procØdØ de la revendication 1, dans lequel la sØlection comprend la sØlection d une configur canal correspondant au dØbit de donnØes pendant la trame temporelle.

5. Le procØdØ de la revendication 1, dans lequel la sØlection comprend la sØlection d un format de pa au dØbit de donnØes.

6. Le procØdØ de la revendication 1, dans lequel la sØlection comprend la sØlection d une quantitØ d correspondant au dØbit de donnØes pour transmission durant la trame temporelle.

7. Une station de base (4) configurØe pour Ømettre un signal vers une station mobile (6) pendant un sur un canal sans fil, la trame temporelle comprenant une pluralitØ de crØneaux temporels, la comprenant :

   des moyens de rØception depuis la station mobile (6) d un message de requŒte de donnØes, me contenant une indication d une mesure de qualitØ du canal sans fil ;
   des moyens de sØlection d un dØbit de donnØes qui est basØ sur ladite indication dans le messa
   des moyens d Ømission du signal audit dØbit de donnØes,

   caractØrisØe en ce que
   l indication dans le message DRC est basØe sur un signal pilote transmis via un canal pilote de la station de base (4), et le message DRC est re u   chaque crØneau temporel   la station de b

8. La station de base (4) de la revendication 7, dans laquelle le message DRC et des donnØes de tr concurremment sur des canaux en phase et en quadrature.

9. La station de base (4) de la revendication 7, dans laquelle les moyens de sØlection comprenner sØlection du dØbit de donnØes parmi un ensemble prØdØterminØ de dØbits de donnØes.

10. La station de base (4) de la revendication 7, dans laquelle les moyens de sØlection du dØbit de do des moyens de sØlection d une configuration de codage de canal correspondant au dØbit de donnØ

11. La station de base (4) de la revendication 7, dans laquelle les moyens de sØlection du dØbit de do des moyens de sØlection d un format de paquet correspondant au dØbit de donnØes.

12. La station de base (4) de la revendication 7, dans laquelle les moyens de sØlection du dØbit de do des moyens de sØlection d une quantitØ de donnØes utilisateur correspondant au dØbit de donnØes p durant la trame temporelle.

13. La station de base (4) de la revendication 7,
   dans laquelle lesdits moyens de rØception comprennent un rØcepteur configurØ pour recevoir de le message DRC contenant une indication de ladite mesure de qualitØ du canal sans fil ; et
   dans laquelle lesdits moyens d Ømission comprennent un Ømetteur couplØ au rØcepteur et configu le signal durant ladite trame temporelle audit dØbit de donnØes qui est basØ sur le message DRC

14. La station de base (4) de la revendication 13, comprenant en outre un ØlØment sØlecteur (14) co et   l Ømetteur et configurØ pour sØlectionner le dØbit de donnØes sur la base du message DRC r

15. La station de base (4) de la revendication 14, dans laquelle l ØlØment sØlecteur (14) est confi le dØbit de donnØes parmi un ensemble prØdØterminØ de dØbits de donnØes.

16. La station de base (4) de la revendication 14, dans laquelle l ØlØment sØlecteur (14) est confi une configuration de codage de canal pour Ømission du signal pendant la trame temporelle, dans figuration de codage de canal sØlectionnØe correspond au dØbit de donnØes.

17. La station de base (4) de la revendication 14, dans laquelle l ØlØment sØlecteur (14) est confi un format de paquet pour Ømission du signal durant la trame temporelle, dans laquelle le format de correspond au dØbit de donnØes.

18. La station de base (4) de la revendication 14, dans laquelle l ØlØment sØlecteur (14) est confi une quantitØ de donnØes utilisateur pour Ømission du signal durant la trame temporelle, dans l sØlectionnØe de donnØes utilisateur correspond au dØbit de donnØes.

19. Un procØdØ pour contr ler un dØbit de donnØes d un signal re u par une station mobile (6) Ømis de base (4) vers la station mobile (6) durant une trame temporelle sur un canal sans fil, la trame une pluralitØ de crØneaux temporels, le procØdØ comprenant :

   l Ømission, depuis la station mobile (6), d un message de requŒte de donnØes, message DRC, de base (4) contenant une indication d une mesure de qualitØ du canal sans fil ; et
   la rØception, la station mobile (6), du signal un dØbit de donnØes durant la trame ter donnØes Øtant basØ sur la mesure de la qualitØ, caractØrisØ en ce que :

      l indication dans le message DRC est basØe sur un signal pilote transmis via un canal pil depuis la station de base (4), et le message DRC est Ømis chaque crØneau temporel dep mobile (6).

20. Le procØdØ de la revendication 19, dans lequel le message DRC et des donnØes de trafic sont t remment sur des canaux en phase et en quadrature.

21. Le procØdØ de la revendication 19, dans lequel l Ømission comprend l Ømission d informations rapport porteuse sur interfØrence pour le canal sans fil.

22. Le procØdØ de la revendication 19, dans lequel la rØception comprend la rØception d un paquet a paquet, dans lequel le format de paquet correspond au dØbit de donnØes.

23. Le procØdØ de la revendication 22, dans lequel la rØception comprend la rØception d un paquet a paquet qui inclut une quantitØ prØdØfinie de bits de codage pour Ømission durant la trame tempo

24. Le procØdØ de la revendication 22, dans lequel la rØception comprend la rØception d un paquet a paquet qui inclut une quantitØ prØdØfinie de bits de donnØes utilisateur pour transmission duran

25. Le procØdØ de la revendication 19, comprenant en outre :

   la dØtermination d un rapport porteuse sur interfØrence (C/I) des communications de donnØes re ues sur liaison aller.

26. Le procØdØ de la revendication 19, comprenant en outre :

   la dØtermination d un taux d erreurs de bits (BER) des communications de donnØes re ues sur u

27. Le procØdØ de la revendication 19, comprenant en outre :

   la dØtermination d un taux d erreurs de paquet (PER) des donnØes de communication re ues sur u

28. Le procØdØ de la revendication 19, dans lequel l Ømission du message DRC comprend :

   l Ømission du message DRC sur un canal dØdiØ sur une liaison retour.

29. Le procØdØ de la revendication 19, comprenant en outre :

la dØmodulation des communications de donnØes re ues sur un canal de trafic d une liaison all au dØbit de donnØes ; et
le dØcodage des communications de donnØes re ues sur un canal de trafic d une liaison aller au dØbit de donnØes.

30. Le procØdØ de la revendication 19, comprenant en outre :

la retransmission du message DRC sur une liaison retour.

31. Une station mobile (6) pour recevoir un signal pendant une trame temporelle via un canal sans fi de base (4), la trame temporelle comprenant une pluralitØ de crØneaux temporels, la station mobi

des moyens d Ømission vers la station de base (4) d un message de requŒte de donnØes, mes contenant une indication d une mesure de qualitØ du canal sans fil ; et
des moyens d Ømission depuis la station de base (4) du signal un dØbit de donnØes durant la oø le dØbit de donnØes est basØ sur la mesure de qualitØ,

caractØrisØe en ce que :

l indication dans le message DRC est basØe sur un signal pilote transmis via un canal pilo depuis la station de base (4), et le message DRC est Ømis chaque crØneau temporel depuis la s

32. La station mobile (6) de la revendication 31, dans laquelle le message DRC et les donnØes de t concurremment sur des canaux en phase et en quadrature.

33. La station mobile (6) de la revendication 31, dans laquelle les moyens d Ømission comprennent Ømettre une information indicatrice d un rapport porteuse sur interfØrence pour le canal sans fil.

34. La station mobile (6) de la revendication 31, dans laquelle les moyens de rØception comprennent dØterminer un format de paquet du signal re u, oø le format de paquet correspond au dØbit de d

35. La station mobile (6) de la revendication 31, dans laquelle les moyens de rØception comprennent dØterminer une configuration de codage de canal pour dØcoder le signal, oø la configuration d correspond au dØbit de donnØes.

36. La station mobile (6) de la revendication 31,
dans laquelle lesdits moyens d Ømission comprennent un Ømetteur configurØ pour Ømettre vers la (4) le message DRC contenant une indication de ladite mesure de qualitØ du canal sans fil ; et dans laquelle lesdits moyens de rØception comprennent un rØcepteur configurØ pour recevoir de l (4) le signal audit dØbit de donnØes durant ladite trame temporelle, oø le dØbit de donnØes es de qualitØ.

37. La station mobile (6) de la revendication 36, dans laquelle le message DRC contenant une indica de qualitØ inclut un rapport porteuse sur interfØrence pour le canal sans fil.

38. La station mobile (6) de la revendication 31, comprenant en outre :

des moyens de dØtermination d un rapport porteuse sur interfØrence (C/I) des communications de donnØes re ues sur une liaison aller.

39. La station mobile (6) de la revendication 31, comprenant en outre :

des moyens de dØtermination d un taux d erreurs de bits (BER) des communications de donnØe une liaison aller.

40. La station mobile (6) de la revendication 31, comprenant en outre :

des moyens de dØtermination d un taux d erreurs de paquet (PER) des donnØes de communication

une liaison aller.

41. La station mobile (6) de la revendication 31, comprenant en outre :

des moyens d Ømission du message DRC sur un canal dØdiØ sur une liaison retour.

42. La station mobile (6) de la revendication 31, comprenant en outre :

des moyens de dØmodulation des communications de donnØes re ues sur un canal de trafic d une conformØment au dØbit de donnØes ; et
des moyens de dØcodage des communications de donnØes re ues sur un canal de trafic d une l conformØment au dØbit de donnØes.

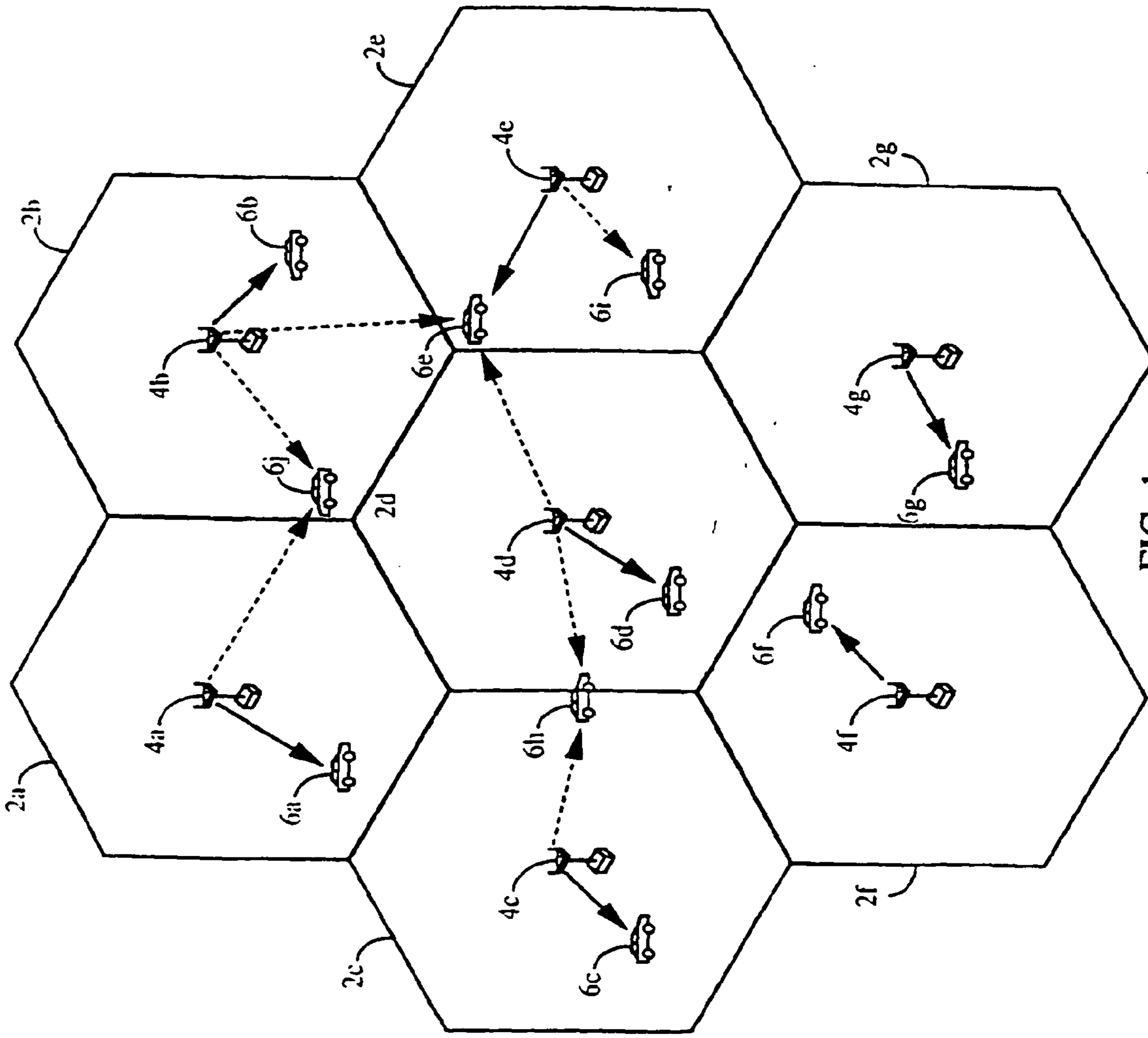

FIG. 1

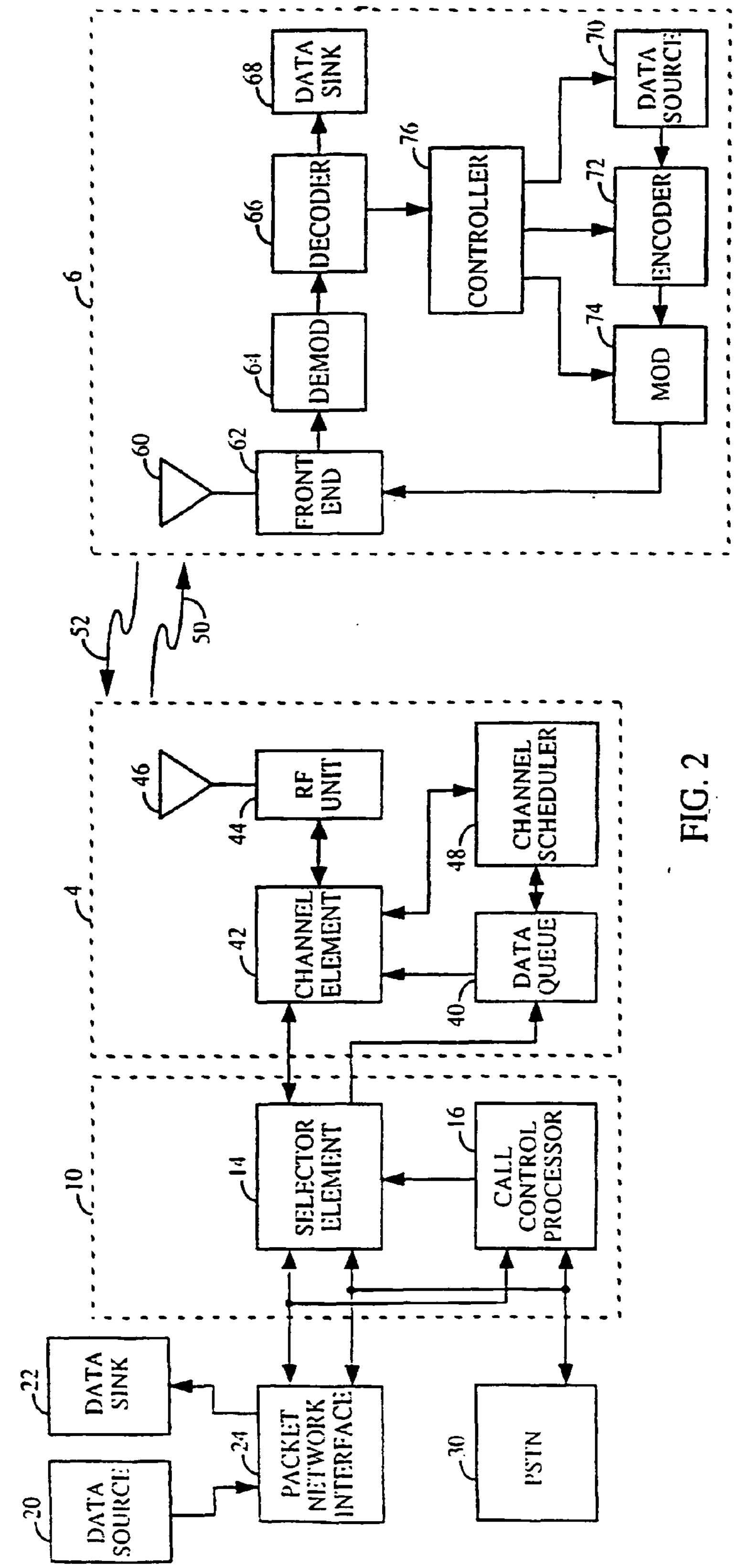
DATA SINK
DECODER
DEMOD
FRONT END
CONTROLLER
DATA SOURCE
ENCODER
MOD
RF UNIT
CHANNEL ELEMENT
CHANNEL SCHEDULER
DATA QUEUE
SELECTOR ELEMENT
CALL CONTROL PROCESSOR
DATA SINK
DATA SOURCE
PACKET NETWORK INTERFACE
PSTN

FIG. 2

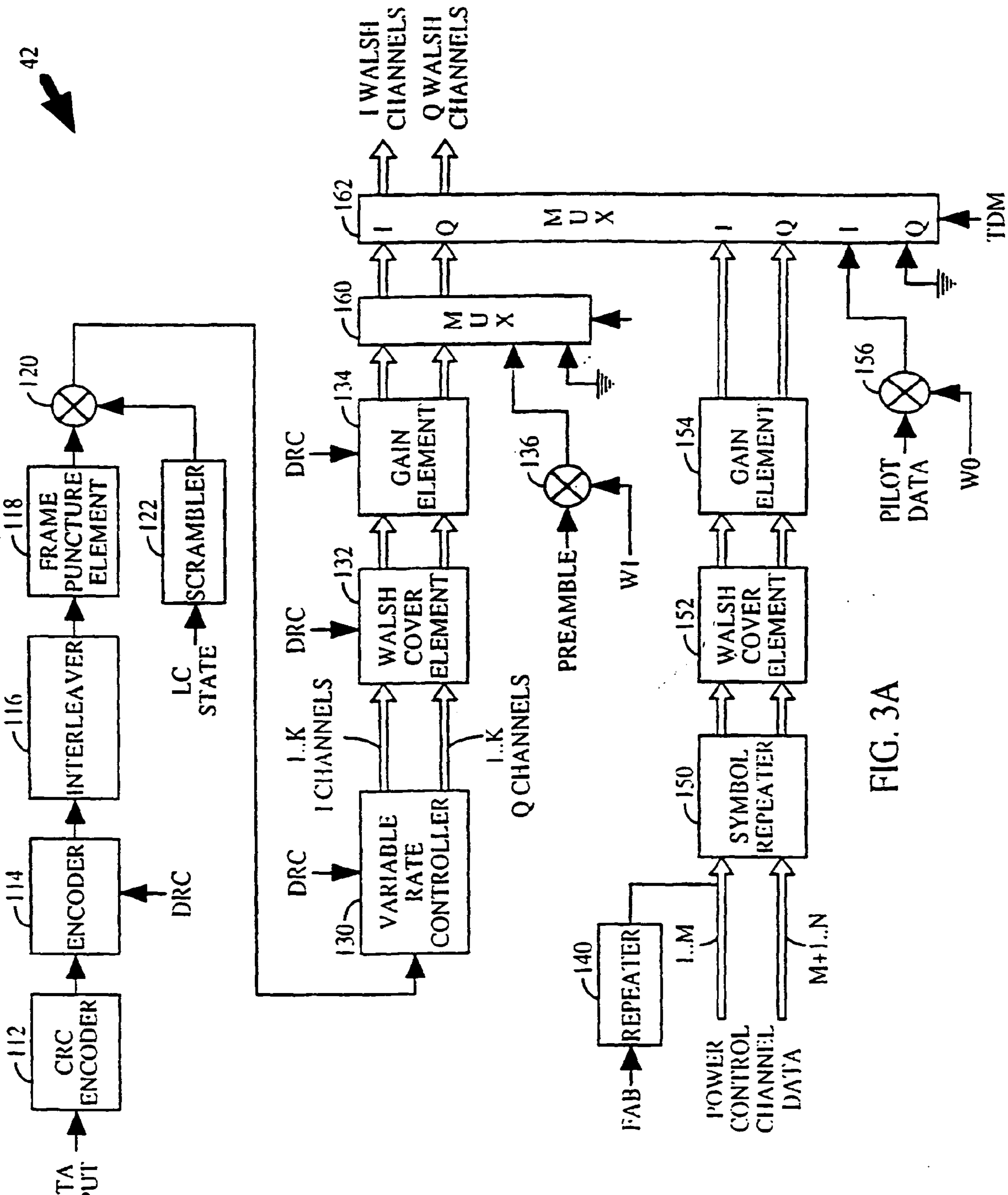
42
DATA INPUT
112
CRC ENCODER
114
ENCODER
DRC
116
INTERLEAVER
118
FRAME PUNCTURE ELEMENT
120
122
SCRAMBLER
LC STATE
130
VARIABLE RATE CONTROLLER
DRC
1..K I CHANNELS
1..K Q CHANNELS
132
WALSH COVER ELEMENT
DRC
134
GAIN ELEMENT
DRC
136
PREAMBLE
W1
160
MUX
162
I
Q
MUX
I WALSH CHANNELS
Q WALSH CHANNELS
140
REPEATER
FAB
1..M
M+1..N
POWER CONTROL CHANNEL DATA
150
SYMBOL REPEATER
152
WALSH COVER ELEMENT
154
GAIN ELEMENT
156
PILOT DATA
W0
TDM

FIG. 3A

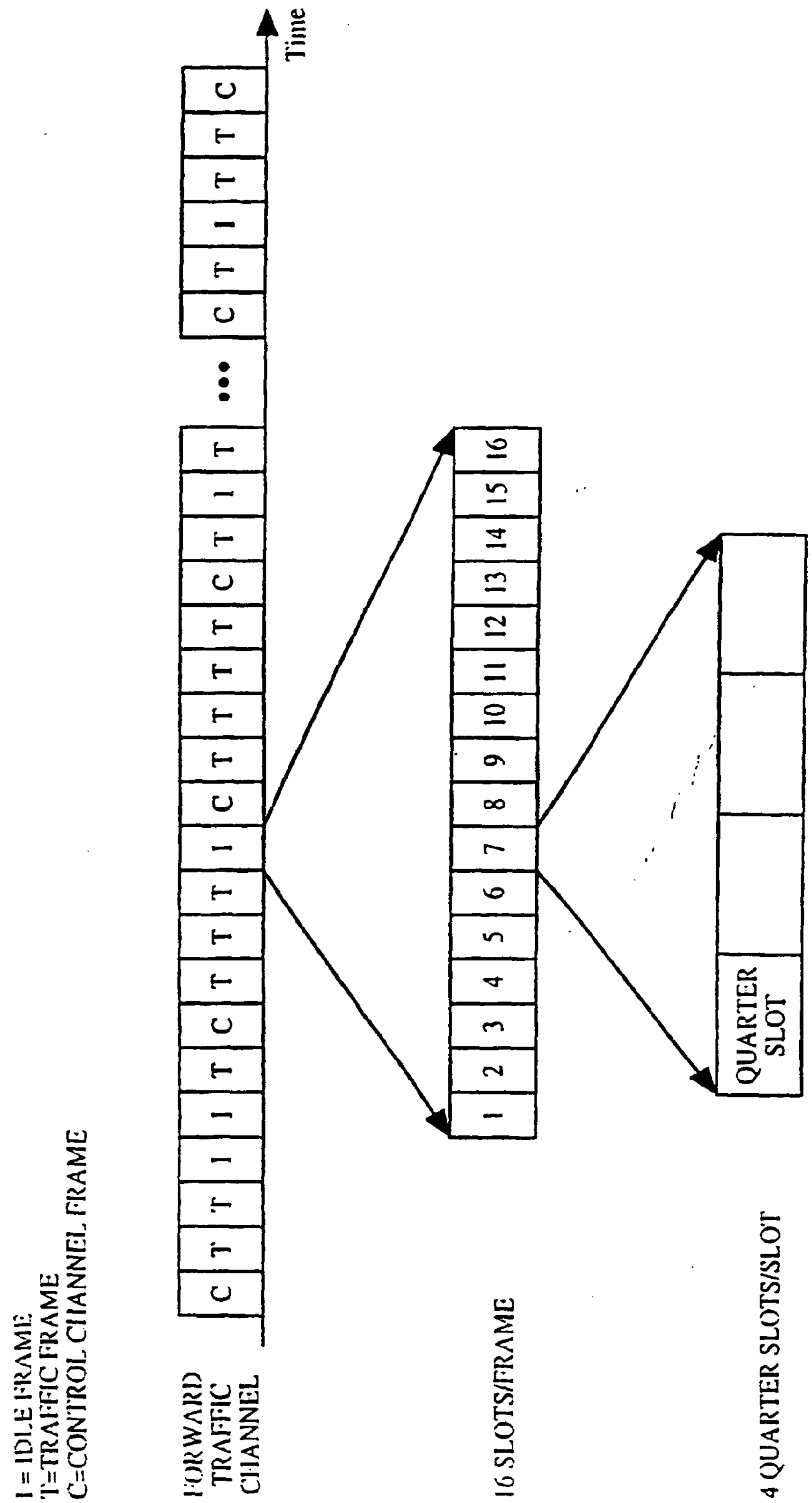
I = IDLE FRAME
T=TRAFFIC FRAME
C=CONTROL CHANNEL FRAME
FORWARD TRAFFIC CHANNEL
C T T I I T C T T T I C T T T T C T I T
C T I T T C
Time
16 SLOTS/FRAME
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
4 QUARTER SLOTS/SLOT
QUARTER SLOT

FIG. 4A

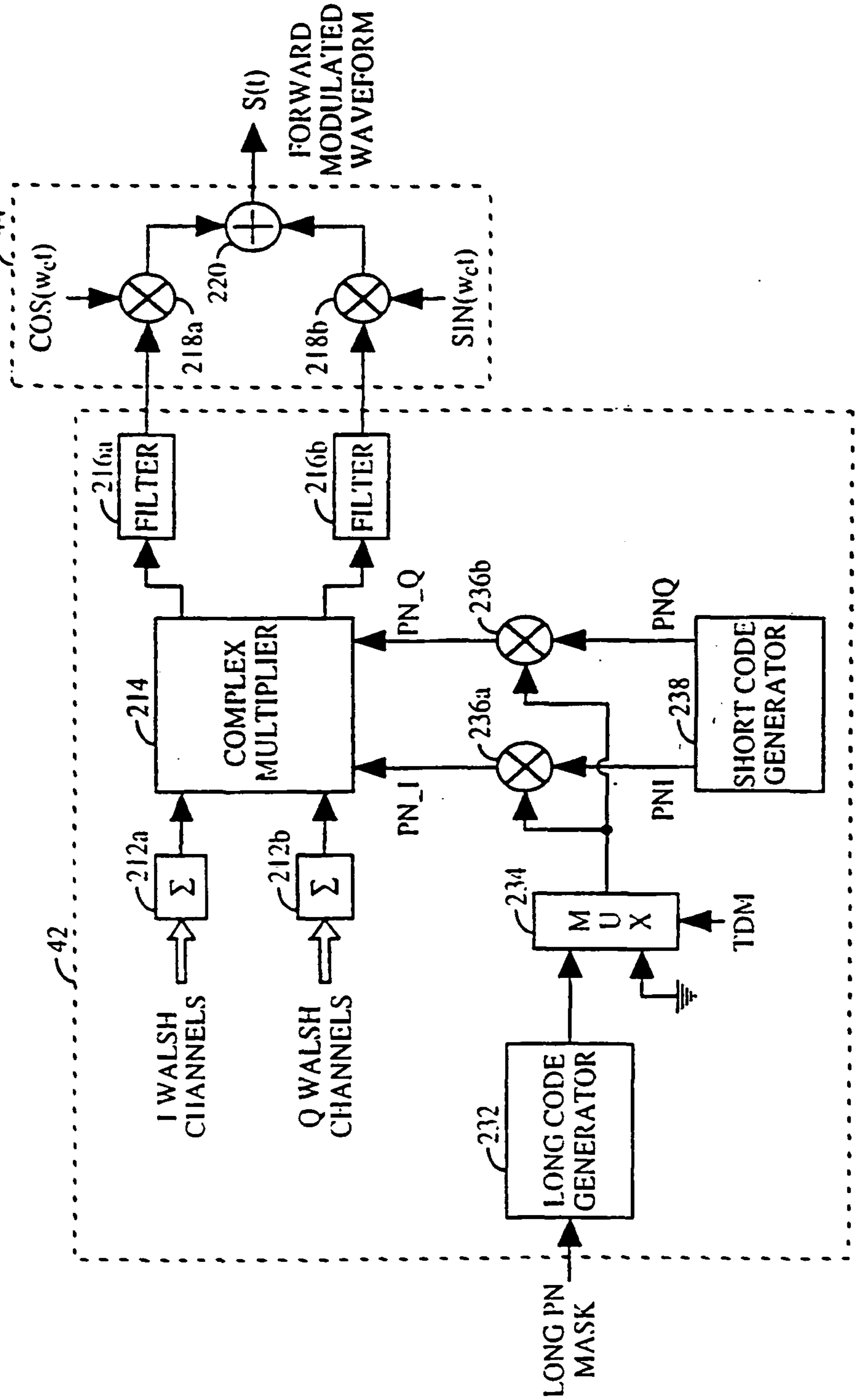
44
COS($w_c t$)
218a
220
S(t)
FORWARD MODULATED WAVEFORM
218b
SIN($w_c t$)
42
216a
FILTER
216b
FILTER
I WALSH CHANNELS
212a
Σ
Q WALSH CHANNELS
212b
Σ
214
COMPLEX MULTIPLIER
PN_I
PN_Q
236a
236b
238
SHORT CODE GENERATOR
PNI
PNQ
234
MUX
TDM
232
LONG CODE GENERATOR
LONG PN MASK

FIG. 3B

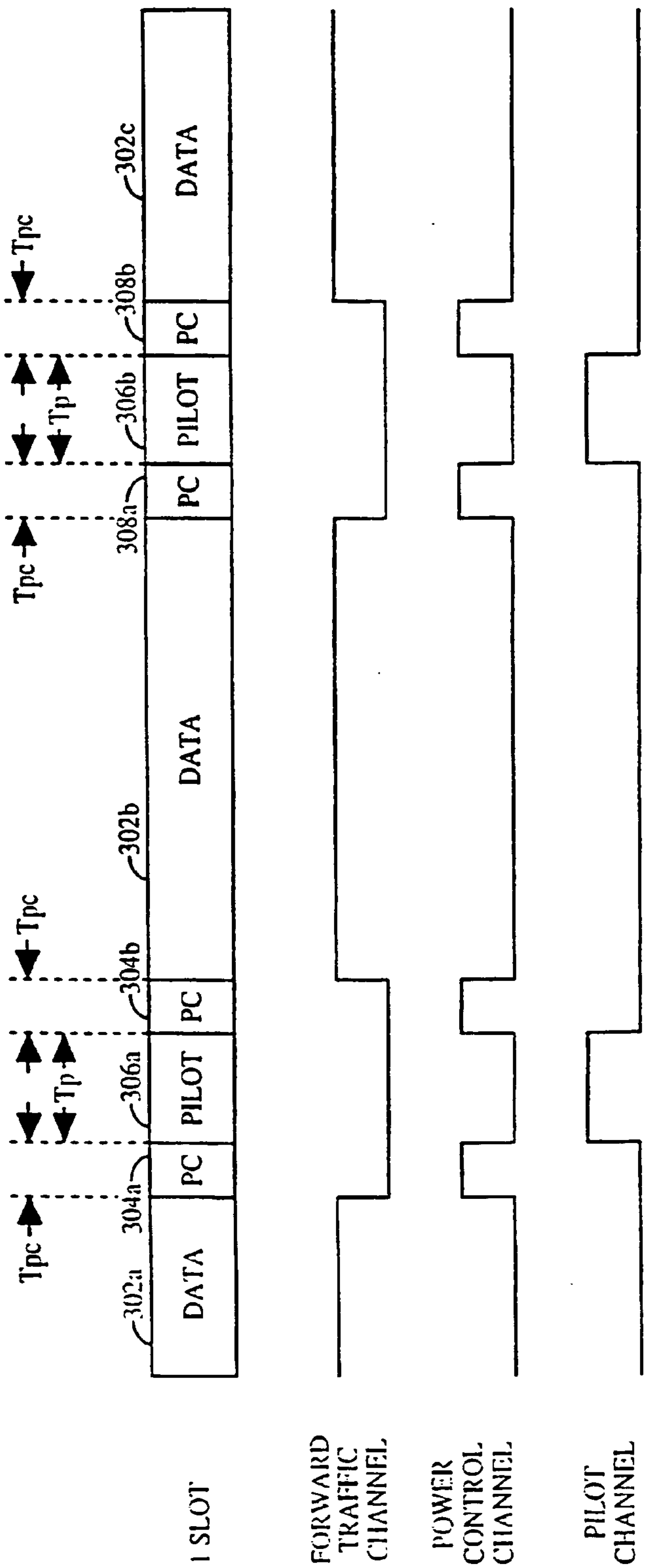
1 SLOT
FORWARD TRAFFIC CHANNEL
POWER CONTROL CHANNEL
PILOT CHANNEL
DATA
PC
PILOT
PC
DATA
PC
PILOT
PC
DATA
302a
304a
306a
304b
302b
308a
306b
308b
302c
Tpc
Tp
Tpc
Tpc
Tp
Tpc

FIG. 4B

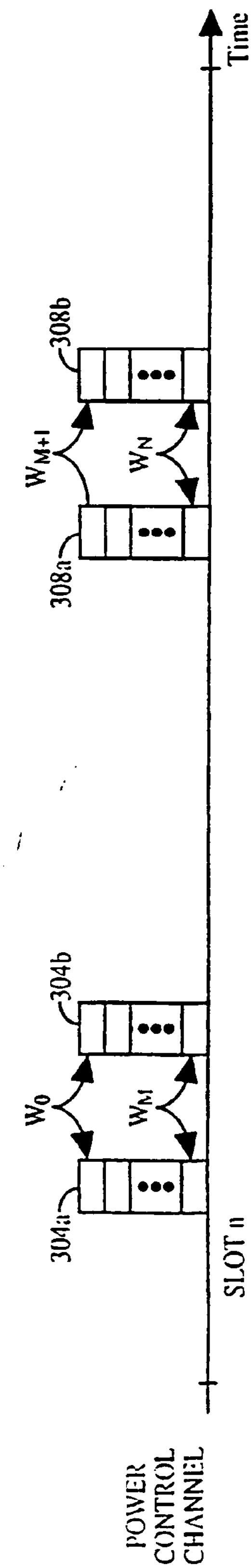
POWER CONTROL CHANNEL
304a
304b
308a
308b
W_0
W_M
W_{M+1}
W_N
SLOT n
Time

FIG. 4C

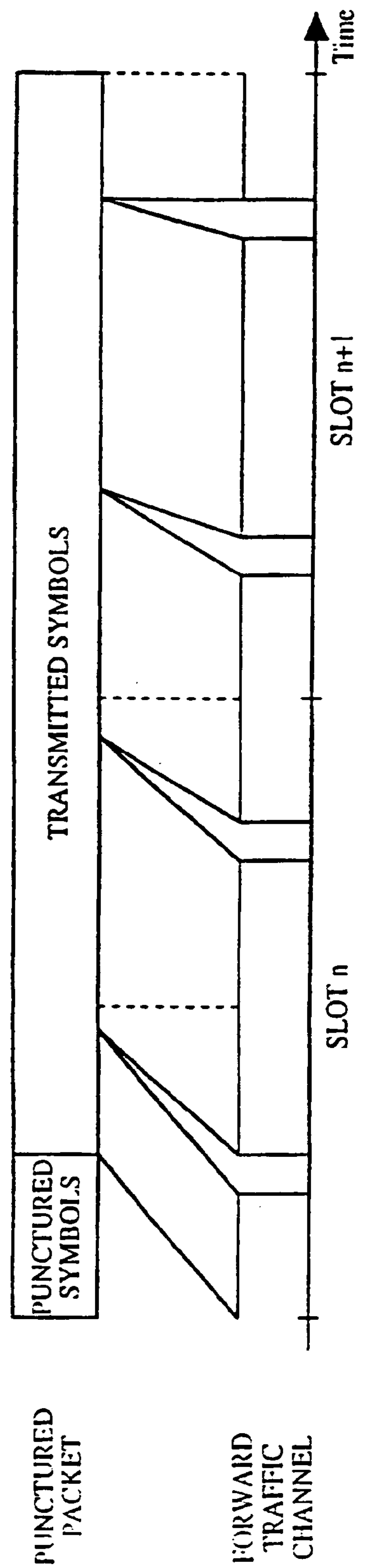
PUNCTURED PACKET
FORWARD TRAFFIC CHANNEL
PUNCTURED SYMBOLS
TRANSMITTED SYMBOLS
SLOT n
SLOT n+1
Time

FIG. 4D

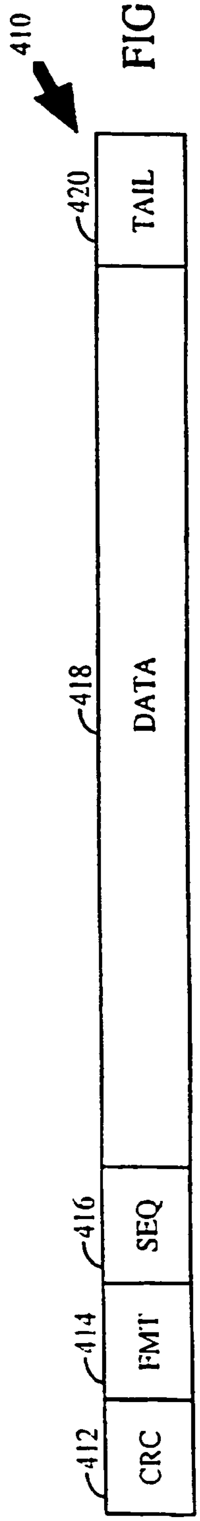

FIG. 4E

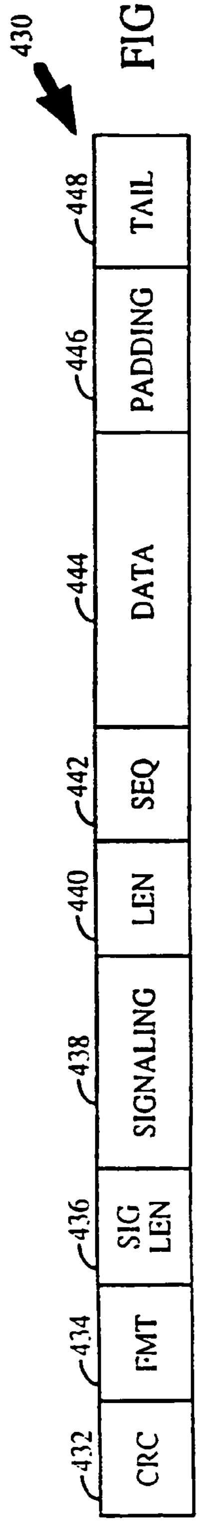

FIG. 4F

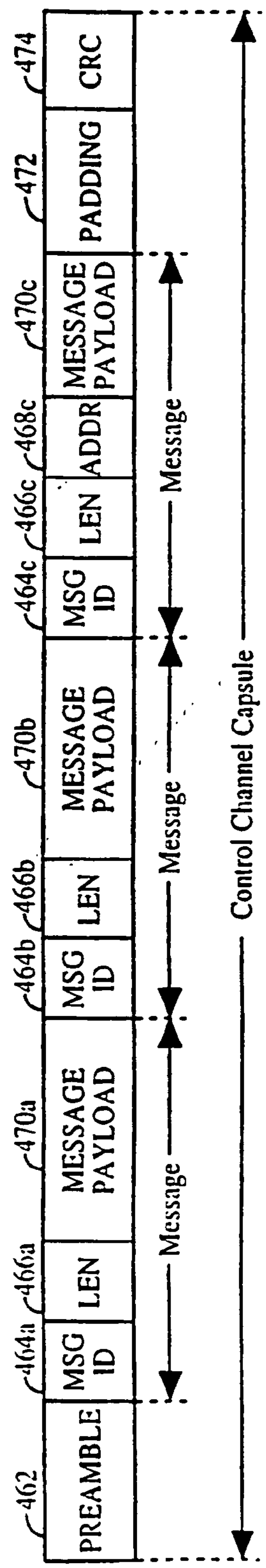

FIG. 4G

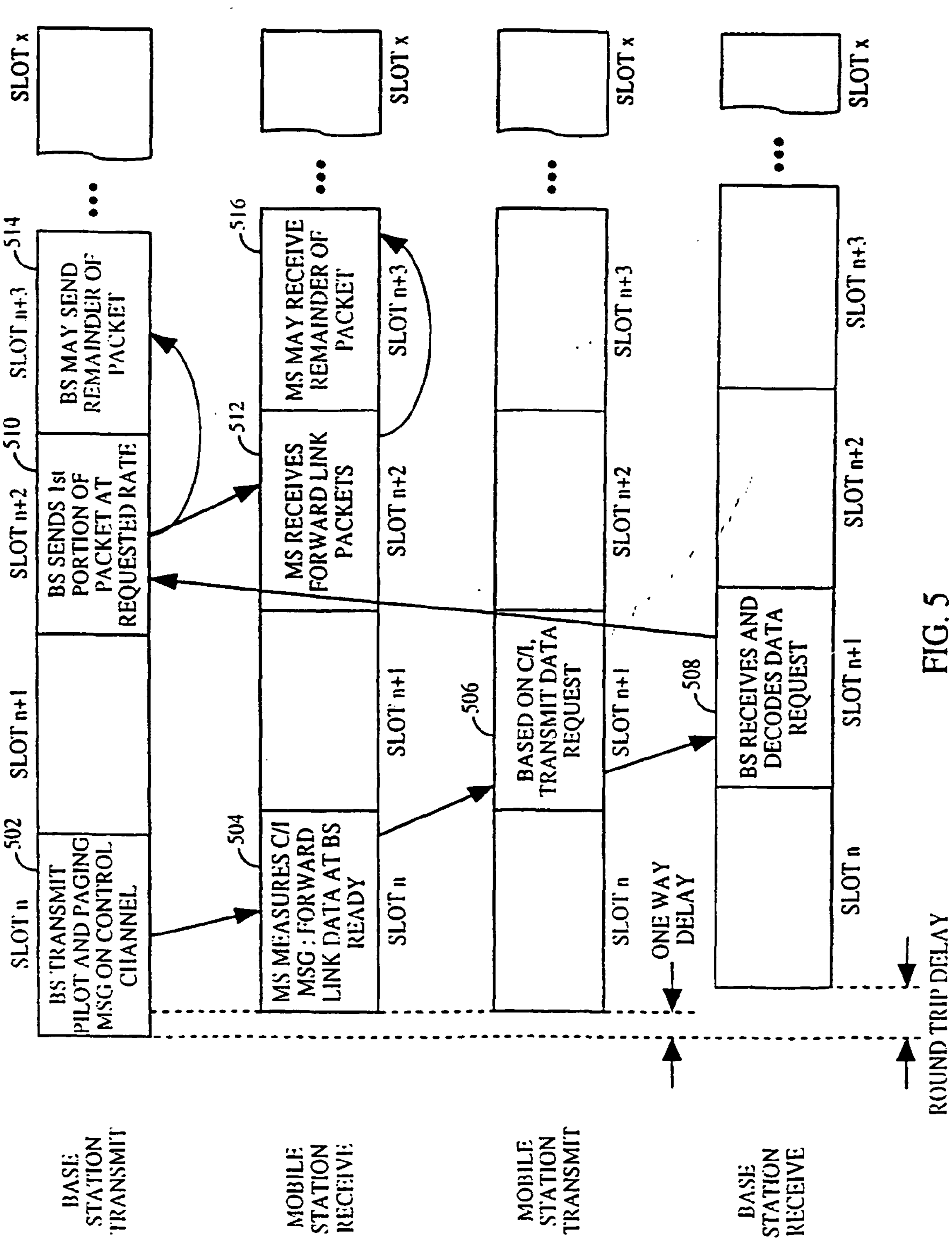
BASE STATION TRANSMIT
MOBILE STATION RECEIVE
MOBILE STATION TRANSMIT
BASE STATION RECEIVE
SLOT n
SLOT n+1
SLOT n+2
SLOT n+3
SLOT x
502
BS TRANSMIT PILOT AND PAGING MSG ON CONTROL CHANNEL
504
MS MEASURES C/I MSG : FORWARD LINK DATA AT BS READY
506
BASED ON C/I, TRANSMIT DATA REQUEST
508
BS RECEIVES AND DECODES DATA REQUEST
510
BS SENDS 1st PORTION OF PACKET AT REQUESTED RATE
512
MS RECEIVES FORWARD LINK PACKETS
514
BS MAY SEND REMAINDER OF PACKET
516
MS MAY RECEIVE REMAINDER OF PACKET
ONE WAY DELAY
ROUND TRIP DELAY

FIG. 5

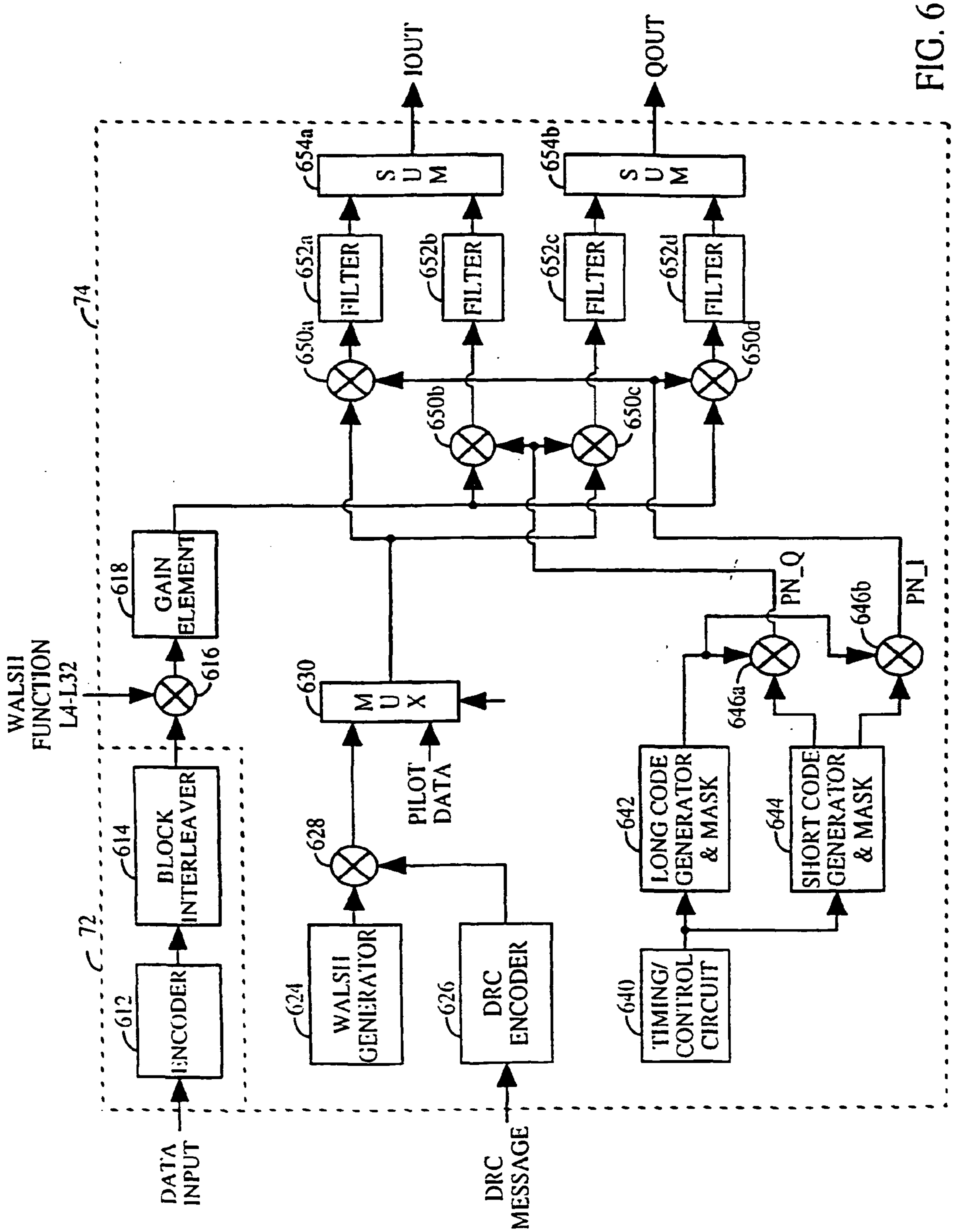
DATA INPUT
72
612
ENCODER
614
BLOCK INTERLEAVER
WALSH FUNCTION L4-L32
616
618
GAIN ELEMENT
74
DRC MESSAGE
626
DRC ENCODER
624
WALSH GENERATOR
628
PILOT_DATA
630
M U X
640
TIMING/CONTROL CIRCUIT
642
LONG CODE GENERATOR & MASK
644
SHORT CODE GENERATOR & MASK
646a
646b
PN_Q
PN_I
650a
650b
650c
650d
652a
FILTER
652b
FILTER
652c
FILTER
652d
FILTER
654a
SUM
654b
SUM
IOUT
QOUT

FIG. 6

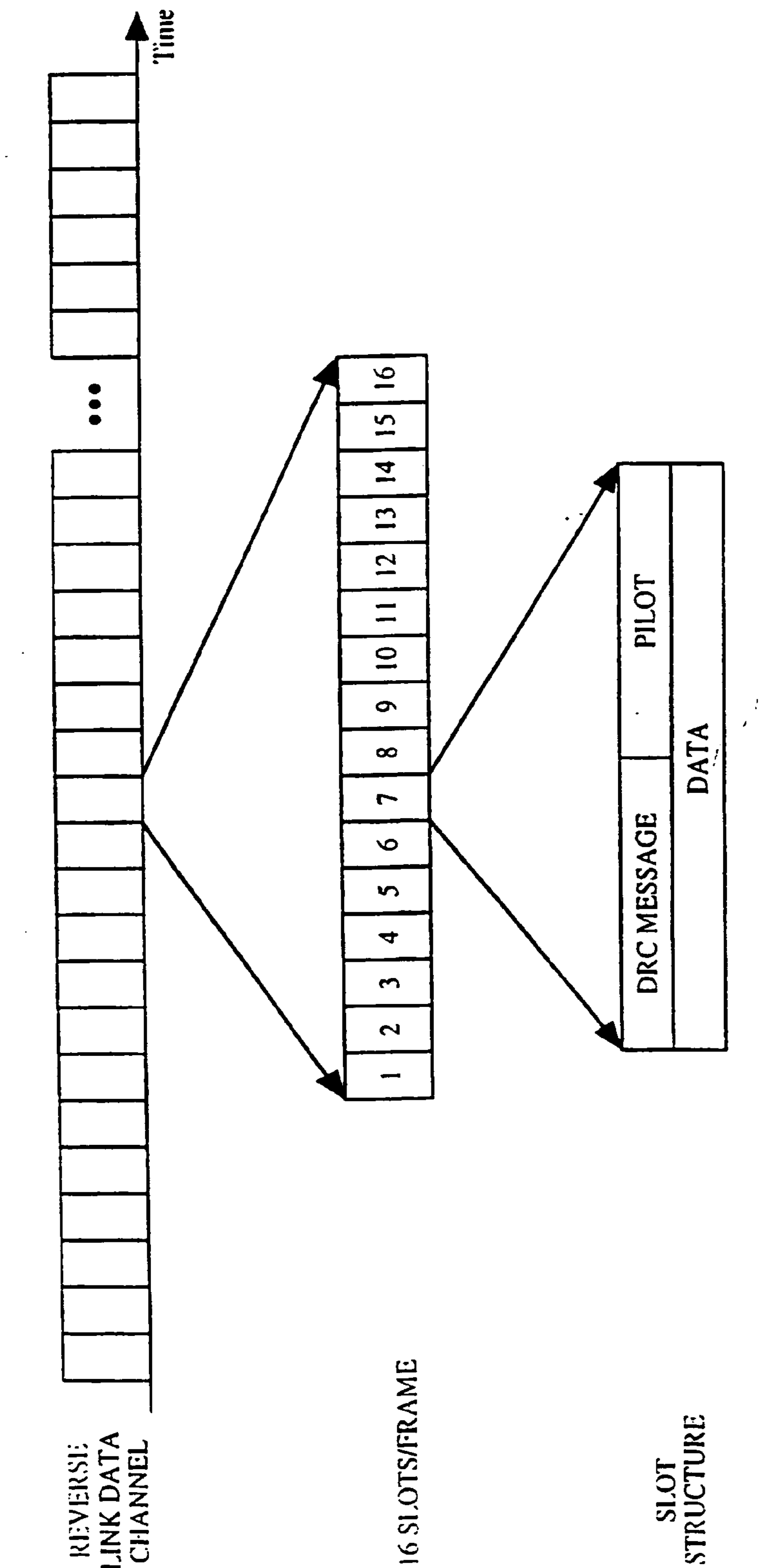
Time
REVERSE LINK DATA CHANNEL
16 SLOTS/FRAME
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
SLOT STRUCTURE
DRC MESSAGE
PILOT
DATA

FIG. 7A

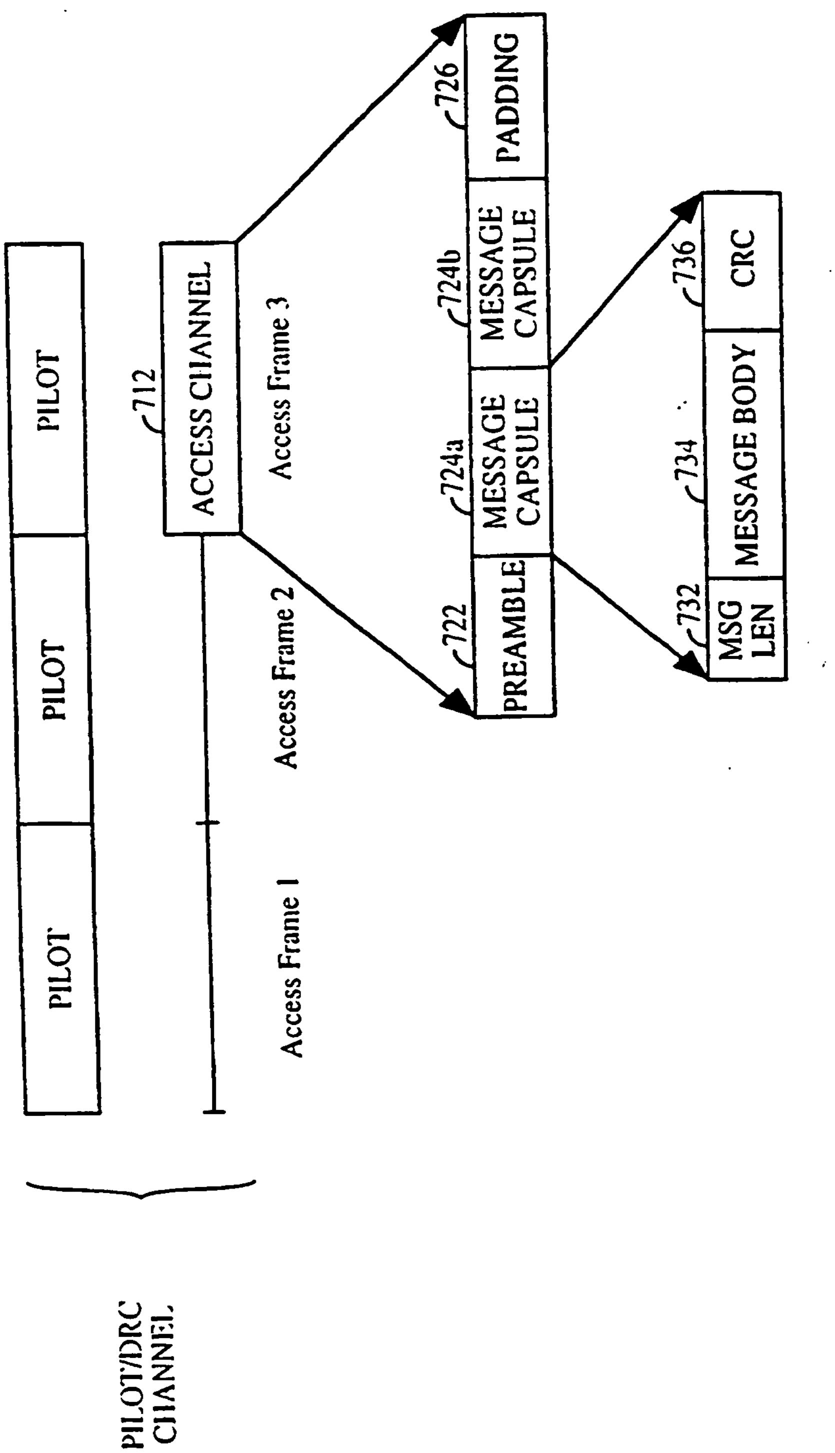
PILOT/DRC CHANNEL
PILOT
PILOT
PILOT
712
ACCESS CHANNEL
Access Frame 1
Access Frame 2
Access Frame 3
722
PREAMBLE
724a
MESSAGE CAPSULE
724b
MESSAGE CAPSULE
726
PADDING
732
MSG LEN
734
MESSAGE BODY
736
CRC

FIG. 7B

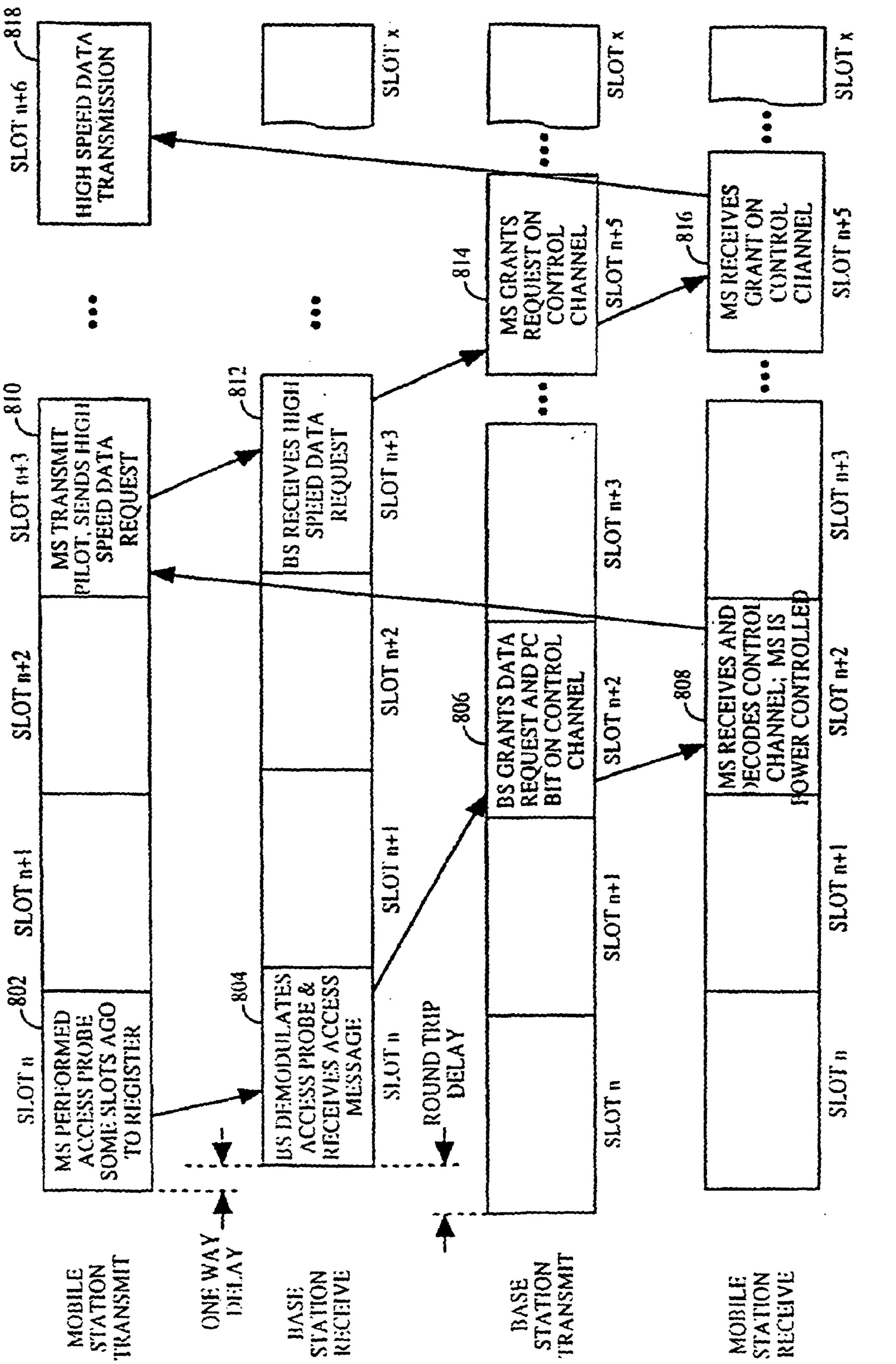
MOBILE STATION TRANSMIT
ONE WAY DELAY
BASE STATION RECEIVE
ROUND TRIP DELAY
BASE STATION TRANSMIT
MOBILE STATION RECEIVE
SLOT n
SLOT n+1
SLOT n+2
SLOT n+3
SLOT n+5
SLOT n+6
SLOT x
802
MS PERFORMED ACCESS PROBE SOME SLOTS AGO TO REGISTER
804
BS DEMODULATES ACCESS PROBE & RECEIVES ACCESS MESSAGE
806
BS GRANTS DATA REQUEST AND PC BIT ON CONTROL CHANNEL
808
MS RECEIVES AND DECODES CONTROL CHANNEL; MS IS POWER CONTROLLED
810
MS TRANSMIT PILOT, SENDS HIGH SPEED DATA REQUEST
812
BS RECEIVES HIGH SPEED DATA REQUEST
814
MS GRANTS REQUEST ON CONTROL CHANNEL
816
MS RECEIVES GRANT ON CONTROL CHANNEL
818
HIGH SPEED DATA TRANSMISSION

FIG. 8

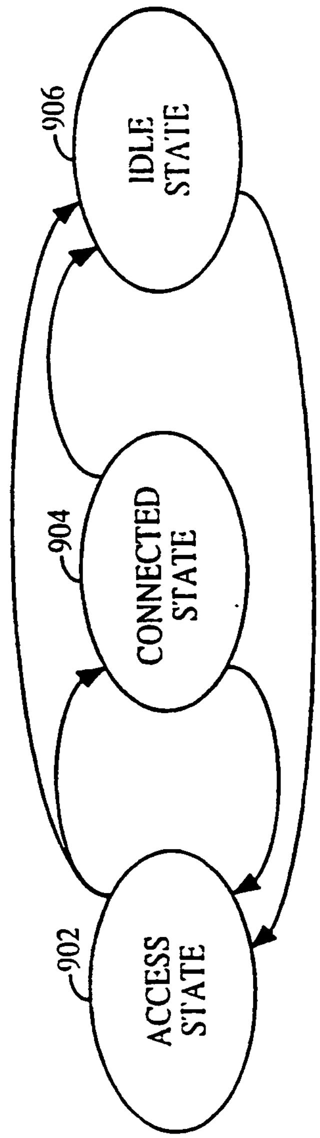

FIG. 9

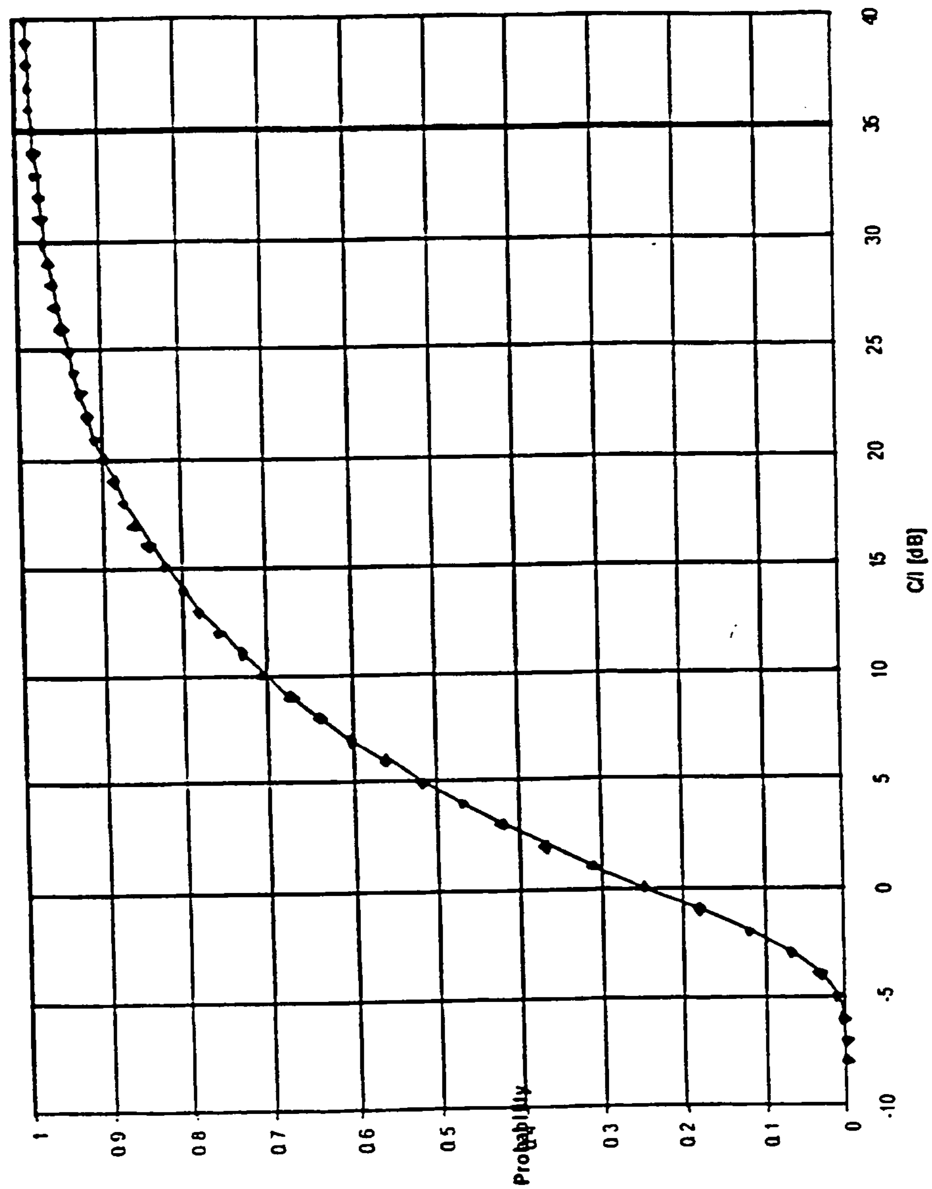
Probability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-10
-5
0
5
10
15
20
25
30
35
40
C/I [dB]

FIG. 10

REFERENCES CITED IN THE DESCRIPTION

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